ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXVII. No. 16.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....367, 388, 389

TECHNICAL ARTICLES:

The Water-Works of Birmingham, Ala. (*illustrated*)..... 368
The Engineering Schools of the United States, V..... 371
The Albany St. Masonry Arch Bridge (*illustrated*)..... 373
Pumping Engine Tests at Lowell, Mass. (*illustrated*)..... 374
Filter Bed of the Water-Works at Raton, N. Mex. (*illustrated*)..... 375
The Young Reversible Nut Lock (*illustrated*)..... 375
The Seep-Water Problem at Cairo, Ill. (*illustrated*)..... 376
The Comparative Merits of Various Systems of Car Lighting, XV..... 381
Electrical Traction..... 383
A Drop Test of Nickel Steel (*illustrated*)..... 384
Government Timber Tests..... 384
Locomotive for Mixed Traffic (*illustrated*)..... 385
South Australian Railways..... 385
Natural Gas in the Salt Lake Basin..... 385
A Siphon Flushing Device (*illustrated*)..... 385
A Large Water Softening Plant (*illustrated, with inset*)... 386
An End Adjusting Gear for Drawbridges (*illustrated*)... 386
Tests of Structural Wrought Iron and Steel..... 387
Weather Report for March..... 389

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS..... 376, 377

EDITORIAL NOTES..... 378

The Standard Code of the Am. Soc. M. E. for Engine Duty Tests—Duty Test of Pumping Engine at Lowell, Mass.—Test of Nickel Steel under Impact—The Controversy Over the Invention of the Telegraph Alphabet.

EDITORIALS:

Water Softening Plants and Processes..... 378
The Comparative Merits of Various Systems of Car Lighting.. 379

LETTERS TO THE EDITOR:

A Novel Level and Level Rod—Long Cableways..... 380

CONSTRUCTION NEWS.....389—392

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The Diamond Shoal Lighthouse project has been abandoned for the immediate present, or under the contract with the firm of Anderson & Barr, of Jersey City. The reasons for the failure and the severe terms of the contract with the Government have already been given in detail in this journal. Mr. Anderson, however, is confident that a lighthouse can be built on this dangerous shoal, but the plans must be changed and work commenced on a more liberal scale as to foundation, to compensate for rapidly shifting depths on the shoal, and the very exposed nature of the work. He is ready and willing to make another trial, and to profit by his late experience.

The Detroit submarine boat was successfully tested on April 9 in the river near that city. The boat attained a speed of 10 miles per hour under water, turned around and rose and sank under perfect control. The motive power at the surface is steam, but when submerged it is driven by a powerful electric storage battery, with the cells charged by the same engine that runs the boat on the surface.

An electric elevated railway is to be established at Kansas City, Kan., the elevated railway company having been granted an ordinance permitting it to operate its line by electricity instead of steam.

Proposals for the construction of the Chicago drainage canal between Willow Springs and Joliet will be received by the Drainage Board until June 8. The amount of work on the channel between Willow Springs and Joliet is estimated at 11,500,000 cu. yds. of rock and 5,000,000 cu. yds. of earth to be excavated and the building of 287,241 cu. yds. of dry rubble walls, and 244,444 sq. yds. of slope paving. The work is divided into seventeen sections which will be bid upon separately. Mr. Benezette Williams is the Chief Engineer, and the plans and specifications will be on view at the office of the Drainage Board.

The Brooklyn Bridge Trustees issue the following reports for March: The receipts during the month from the carriageways were $6,725.22, an increase of $542.26 over the receipts in March, 1891, and the receipts from railway fares were $96,741.81, an increase of $2,457.33 over the receipts for the corresponding month of last year. The number of single tickets at 3 cts. that was sold during March was 1,603,532, an increase of 81,160 over the number sold in March, 1891, and the number of tickets sold in bunches of 10 at 25 cts. per bunch last month was 1,945,410, an increase of 97,890 tickets over the number sold in March, 1891. The total number of passengers that were carried in the cars during the month was 3,548,962. The expenditures during March were $73,329.39. There is a balance on hand in banks in New York and Brooklyn of $547,629.02.

A chimney 350 ft. high is being built for the Omaha & Grant Smelting Works, in Denver, Colo. It will be an octagon stack, 55 ft. in diameter at the base, placed on a concrete foundation 18 ft. deep, imbedding 20 tons of steel rails. There will be two stacks, one within the other, with a ladder way between. The stack will be banded with 4½-in. wide steel bands every 20 ft., covered by the brick work. The contract price is about $53,000, and it is to be finished in 130 days. The other high chimneys in the United States are as follows: At the Fall River Iron Works, 340 ft., and the Clark Thread Mill stack, in Newark, N. J. The stack at Freiburg is 460 ft. high, counting from the ground.

An improvement in incandescent lamps has been invented by Mr. E. W. Applegate, of Chicago, an electrician in the employ of the Western Union Telegraph Co., which if it proves successful should result in an important reduction in their cost by doing away with the use of platinum wire. The inventor closes the top of the glass bulb with a "lava" head, in which the leading in wires are imbedded, and these wires may be of any metal. In lamps commonly used, platinum wires, fused into glass tubes are used for the leading in wires, and though the amount of platinum required for a single lamp is minute, the aggregated demand has had the effect of largely increasing the price of platinum, and it is now said to be the chief element of cost in lamps. Mr. Applegate also seals an exhaust tube in the head of his lamp and claims his construction to be such that a broken filament can be replaced at slight expense.

The most serious railway accident of the week was a derailment, April 8, on the Pittsburg, Mckeesport & Youghiogheny R. R. near Connellsville, Pa. It is said that one of the driving wheel tires broke, the engine leaving the rails and being overturned. Two men were killed and another was fatally injured.—A freight train on the Housatonic R. R. was ditched by a derailing switch at the crossing of the Housatonic and New York & New England railways at Hawleyville, Conn., April 7. A New York & New England freight train was passing the crossing at the time and a collision was thus averted.

One span of the Clarissa St. bridge across the Genesee River at Rochester N. Y., gave away April 6. Mr. Peacock, the City Engineer, states that the bridge was 388 ft. 6 ins. long over all, with three spans, and was about 30 years old. The span which failed was 125 ft. 6 ins. long, and was a Whipple bowstring truss, with cast iron arch, pins and floor beams, the other members being of wrought iron. The cause of the accident is not definitely known, as all the iron work is at the bottom of the river, which is about 8 ft. deep. A contractor was engaged in raising the east end of the span 1 ft., and the accident occurred just as work was being commenced in the morning.

A locomotive boiler explosion occurred on the Illinois Central R. R. at Chicago, April 5. The engine was hauling a train from Harvey, and was passing 70th St., when the accident occurred, the cause being the giving way of the crown sheet. The engineman and fireman were seriously injured.—The boiler of a switch engine on the Missouri, Kansas & Texas Ry. exploded April 3, while the engine was standing on the track at Colmesneil, Tex. Nobody was near the engine at the time.

The new industries "established" in the South during the first three months of the current year as reported in the "Chattanooga Tradesman" amounted to 508, against 840 in the corresponding period of 1891, and 823 in 1890. The comparative figures are of some interest as shown in the gradual dying out of "boom" conditions in the South; but we are inclined to discount very largely the above figures when we see that among the list are 63 railways. If "established" means no more for other industries in the list than it does for railways, our contemporary would give its readers a more accurate idea of Southern progress if it were to say that 508 new industries had been incorporated or projected with some prospect of construction, in the South during the past quarter. There is a wide difference between incorporating an enterprise and "establishing" it. On the other hand, as the "Tradesman's" list includes 122 "woodworking" establishments, and 65 "miscellaneous," the capital represented in many of these enterprises is probably not large, and the term "established" may be a fairly accurate statement of their condition.

The sewage farm at Adelaide, South Australia, according to the last Public Works Report, was operated at a loss of about $2,900 for the year ending June 30, 1891. The report states that "as the loss continues we propose to lease the garden and discontinue breeding horses, and thus reduce the establishment to as low a limit as possible." The farm was in good order at the time of the report and all the sewage had been satisfactorily disposed of during the year, and there had been no complaints during the year of odors from the farm. Alex. B. Moncrieff is Engineer-in-Chief of the Public Works Department.

The San Domingo Improvement Co. has been incorporated in New Jersey, to obtain concessions, etc., for the issue of a public loan, and to build a railway in San Domingo, from Punta Plata to Santiago. The capital stock is fixed at $2,000,000. No names are yet published.

A twin compound, high duty, 20,000,000-gallon pumping engine will soon be erected in the Spring Garden Water-Works, Philadelphia, by the Southwark Foundry & Machine Co., of that city. The engine is to pump against a head of 250 ft. through a 48-in. main about 14,000 ft. long. It has two high pressure steam cylinders, each 3 ft. 8 ins. diameter, and two low pressure cylinders, each 7 ft. 4 ins. in diameter. The two pump plungers are 37 in. in diameter, and are of the double-acting, outside-packed type. The steam cylinders are vertical and the pump cylinders horizontal. A triangular walking beam is used in transmitting power to the pumps, and the flywheel on the main shaft is 20 ft. in diameter. The entire pump weighs about 1,000,000 lbs.; the flywheel weighs about 100,000 lbs., and the bed plate 80,000 lbs. The pump will occupy a floor space of 40 by 30 ft., and will be 35 ft. high.

The trade schools of New York are richer by the amount of $500,000 given by Mr. Pierpont Morgan. These schools, at First Ave. and 67th St., graduated 521 pupils last week, chiefly in plumbing, bricklaying, painting, plastering, carpentry, tailoring and stone cutting.

Three rapid transit referees are to be appointed to decide upon the advisability of erecting the proposed roads in New York. This is in accordance with the terms of the act appointing the original commission, and is intended to meet the lack of unanimous consent of property owners along the route. It is expected that they will report in two months.

Analyses of river water to determine their values for fertilizing and irrigating purposes have been made recently by Mr. A. N. Pearson, of Melbourne, Victoria, Chemist for Lands, Agriculture and Victorian Water Supply. The results of the 48 analyses made during the year ending June 30, 1891, are presented in the last report of the Minister of the Victorian Water Supply. The samples were from the Murray, Goulbourn, Werribee and Lerderburg rivers. Mr. Pearson states that the richness of the waters was highest during summer and lowest as winter approached. Also, that the waters of the Murray and Goulburn Rivers, as a rule, increased in richness with sudden rises in their height. The principal fertilizing value of the waters has been found through these and previous analyses to be in the matter in solution rather than in the sediment. In most cases the sediments were so small that all the fertilizing ingredients could not be determined, but so far as could be stated, the value of the sediment was from 1-20 to 1-5 that of the solution. The tables accompanying the report show for each ingredient its weight in pounds and value in pence; the total value of the matter in sediment and solution; and the combined value of these two, when either 1 or 20 ins. of water is applied to an acre of land.

At the York Farm colliery tunnel, near Pottsville, Pa., contractor Dolan drove 307½ ft. of finished tunnel last month, using Ingersoll rock drills and working with safety lamps.

The proposed Duluth drawbridge, to connect Duluth with Minnesota Point, is causing trouble between the general and city governments. Duluth wants the bridge so that it may utilize the point as a railway terminal, and for an extension of docking facilities. The Government owns half the canal cut through to the inner bay, and objects to any obstruction through its engineers. The vessel owners side with the Government, and the decision of the Board of United States Engineers, now discussing the question, is anxiously awaited.

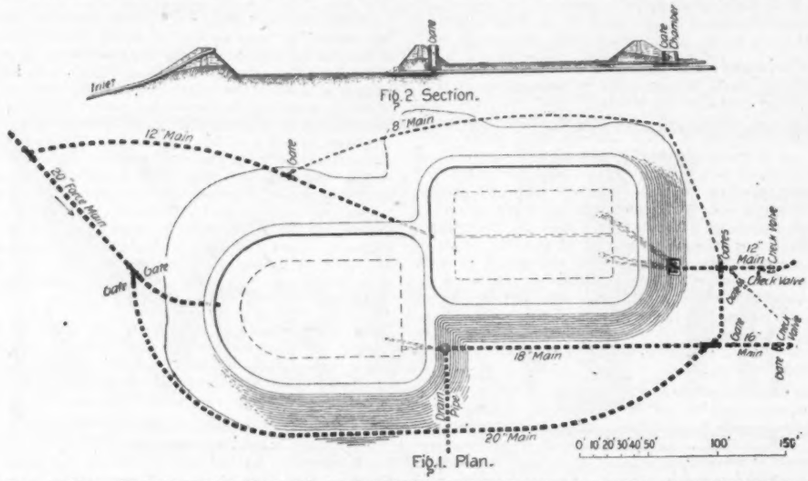
An electric fire-stream signal is a late useful invention. The pipeman, by touching a button at the nozzle of the hose, can signal the engineman to shut off or turn on the stream, or call for help from within a building. The scheme has been successfully tested by the Cincinnati fire department.

Several new steel express cars are being built for the American Express Co., at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Ry. They are to be 50 ft. long, 8 ft. wide and constructed of steel sufficiently thick to deflect a bullet. They are to be burglar-proof as well as fireproof.

THE WATER-WORKS OF BIRMINGHAM, ALA.

By W. J. Milner, Superintendent.

The first water-works for Birmingham were built by the Elyton Land Co. in 1873, under the direction of the late Capt. Travers Daniel. The city had then a population of about 2,000, and the works built were many years in advance of its requirements. They consisted of a small pumping plant of about 500,000 gallons daily capacity, located on Village Creek, two miles north of the city, a service reservoir of 1,000,000 gallons capacity, and about 4½ miles of 2 to 8-in. pipe.



FIGS. 1 AND 2. PROFILE AND PLAN OF OLD RESERVOIRS FOR WATER-WORKS AT BIRMINGHAM ALA.; W. J. Milner, Independent

The writer was placed in charge as superintendent of these works on Jan. 1, 1875, and all improvements or additions thereto since that date have been made under his direction.

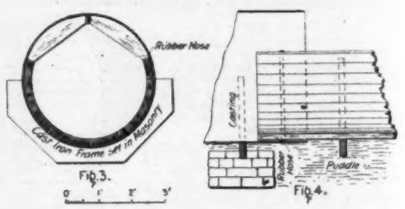
In 1881 the 8-in. force main was replaced with a 12-in. main and a compound condensing duplex Blake engine of 2,250,000 gallons capacity was put in. In the following year, 1882, the engine was duplicated and an additional service reservoir of 2,000,000 gallons capacity was constructed adjoining and connected with the old one, which was enlarged 25 per cent., or to 1,250,000 gallons, by raising its banks 2 1-2 ft. A plan and section of these reservoirs and the pipe and valve connections to them as they are at present are shown by Figs. 1 and 2. They were built on the summit of a hill and occupied all the available space, which fact determined the form and capacity of the last one constructed.

In 1886 the 12-in. force main was again replaced by a larger one, this one being 20 ins. diameter, and other larger mains were laid from the reservoir to the city. A contract was also made with the Deane Steam Pump Co., of Holyoke, Mass., for an engine of 6,000,000 gallons capacity, which was put into operation in the following year, 1887.

During the year 1886 the Birmingham Water-Works Co. was organized by the stockholders of the Elyton Land Co. under a charter previously obtained from the Legislature, and on Jan. 1, 1887, the works was transferred to the new corporation. Dr. H. M. Caldwell was made president and W. J. Milner, secretary and superintendent, and the works begun by the Elyton Land Co. were carried out by the Birmingham Water-Works Co. without any change of plan.

By the year 1885 the city had extended its population over a large territory, draining into Village Creek above the pumping station, which made it necessary to abandon that source. It had been ascertained that it was practicable to bring into the pumping station by means of a canal 30,000 ft. long another creek of about 4,000,000 gallons daily capacity at the driest season, which was not liable to pollution. At the point of diversion was what appeared to be an admirable site for an impounding reservoir, except that it was in the limestone. As the land was cheap, however, and well worth for farming purposes the price at which it was then held, so much of it was purchased as might be needed for that purpose in case it should be found feasible or desirable to build the reservoir.

During the years 1886 and 1887 the canal was constructed. It was in most places merely an open ditch 4 ft. wide at the bottom, with slopes in earth of from 1 to 1 to 1 1-2 to 1. In rock the slopes were irregular according as it happened to break in blasting, being usually from vertical to 1-2 to 1. In a few places water was carried over valleys for short distances through 48-in. wrought iron riveted pipe of 1-4 in. thickness, supported on frame bents of oak. These pipes are supported at the ends on cast iron frames set in masonry. No provision was made for contraction and expansion, which has been a source of much trouble. I have now remedied this in large measure by means of a cheap expansion joint constructed of 1 1-2 in. plank. The plank are dressed to fit the inside diameter of the pipe, as shown by the sketches, Figs. 3 and 4. About a foot from the ends these plank are grooved around the pipe so as to admit a piece of ordinary 3-4-in. rubber hose. The plank are then tightened against the inside of the pipe by wedges at the top com-



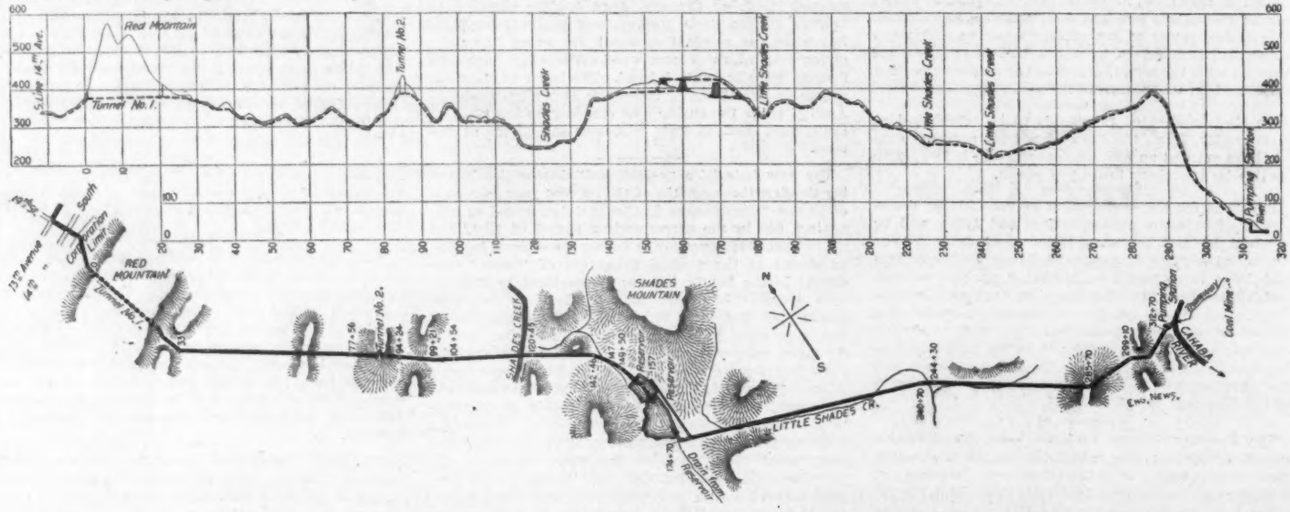
Figs. 3 and 4. Expansion Joint for 48-in. Pipe.

pressing the hose into the groove and making a joint between it and the pipe. The outer ends of the plank are secured to frames set in puddling.

In some places the sides of the canal are protected by dry masonry walls, while in others temporary wooden flumes are put in. Wherever necessary barbed wire fences protect the canal from stock.

This canal furnished all the water supplied to the city from the time of its completion in November, 1887, until Jan. 1, 1891, since which time it has been drawn upon for from 1,000,000 to 3,000,000 gallons daily.

After work on the canal had been in progress some months excavations were commenced at the site of the proposed dam for the storage reservoir. The dam was designed to be 50 ft. high, at which height it was practicable to divert the overflow into another valley. These excavations, however, revealed conditions which created alarm and the work was suspended, although Mr. J. T. Fanning, C. E., who recently examined this site, states that he has



FIGS. 5 AND 6. PROFILE OF PIPE LINE AND MAP SHOWING PUMPING STATION AND RESERVOIRS.

But there were other potent reasons for the abandonment of this dam site. It had by this time become evident that Birmingham would require more water than the available watershed at that point no doubt of being able to construct upon it a reservoir with a dam 30 ft. high.

could be depended upon to furnish. The stockholders and directors being largely interested in the city and being men of broad views, determined to go to a source which afforded practically unlimited supply. Accordingly, in 1888, a new contract having been made with the city, work was begun on the Cahaba River extension.

In order to appreciate the difficulties of this undertaking, some description of the physical features of the country is necessary. Birmingham is situated at the northwesterly base of a ridge locally known as Red Mountain, which extends in a northeasterly and southwesterly direction and forms the divide of the watersheds of the two great river systems draining the State, the Coosa and Alabama on the east, and the Warrior and Tombigbee on the west. The summit of this ridge opposite the city is about 9,000 ft. from the central portion of the city and 400 ft. above it. Parallel with and about three miles from Red Mountain extends another ridge known as Shades Mountain, somewhat higher and much broader than Red Mountain. Between these two principal ridges are several parallel ridges of less magnitude, and a creek known as Shades Creek, which runs along the base of Shades Mountain. This mountain marks the northwestern limit of the Cahaba coal fields, which are drained by the Cahaba River running along the southeastern base of the mountain at a distance of from three to four miles from its summit. The intervening country is badly broken and rugged.

A fortunate gap in Shades Mountain affording convenient passage for a pipe line, and at the same time ample site for reservoirs, determined the location of that portion of the line and also the location of the pumping station.

The vertical rise in the river at extreme floods it was difficult to obtain with exactness. It was found to be something near 30 ft., and one noted freshet, which occurred in July, 1872, commonly called by the natives "The July Fresh," exceeded even 40 ft., if their accounts are to be credited.

The site selected for the pump house and boiler house had reference to these conditions. Figs. 5 and 6 show the location of the pumping station, pipe line and reservoir, and Fig. 6 a profile of the pipe line.

The inlet from the river is of brick, 3 ft. wide, 3 ft. to the spring line of arch, and 250 ft. long, delivering into a circular well, also of brick, 21 ft. in diameter. The pump house is of brick, built for two engines, only one of which has been put in. It is circular, 54 ft. inside diameter at the floor line, which is 27 ft. below the door sill. Fig. 8 shows in some detail the plan of the new intake, the pump well and engine room, and Fig. 9 is a general view of the pumping station and accessories, including, in the distance, the coal tramway bridge over the Cahaba River. Fig. 10 is a plan and Fig. 11 a section of the boiler house, while Figs. 12 and 13 show the coal shed in plan and section. Fig. 14 shows an elevation of the pumping engine, and Fig. 15 a view of the same. The engine in use is a Worthington high duty. The steam cylinders are 28¾ by 57½ ins., water cylinders 19¼ ins. and 48-in. stroke. The plungers of the high duty attachment are 12 ins. in diameter.

The engine in use is a Worthington high duty. The steam cylinders are 28 3-4 by 57 1-2 ins., water cylinders 19 1-4 ins. and 48-in. stroke. The plungers of the high duty attachment are 12 ins. in diameter.

This attachment, for which the manufacturers claim, and not without reason, very decided advantages is the distinguishing feature of this engine, which in other respects is similar in type to the ordinary well known direct acting compound condensing duplex engines made by Henry R. Worthington. A brief description of this distinctive feature may not be out of place here and the accompanying view from a photograph, Fig. 15, will aid in giving an understanding of the device.

It consists of a pair of oscillating cylinders, carried by journals set at right angles to their axes, placed upon frames bolted to the outer end of the water cylinder, one directly above and the other below an extension of the plunger rod. These cylinders are single acting and have each a plunger engaging by means of a pin working in a crosshead with the extension of the plunger rod. When the cylinders and their plungers are both vertical, the engine and crosshead are at mid stroke. Therefore the axes of the cylinders are inclined to the axes of the plunger rod when the engine is at either end of its stroke, this inclination varying with each portion of the stroke. The crosshead end of the oscillating plungers points toward the steam cylinders at one end of the stroke of the engine and away from them at the other end of the stroke.

The compensating cylinders, as they are called, are supplied directly with a constant water pressure of 180 lbs. from the delivery main. Therefore, during the first half of the stroke they are opposing the force in the steam cylinders in a degree varying with

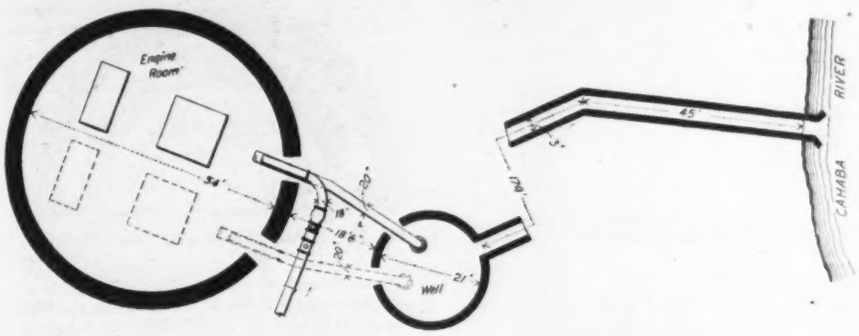


FIG. 8. PLAN OF INTAKE, PUMP WELL AND ENGINE HOUSE

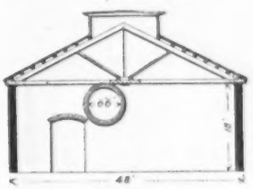


Fig 11.

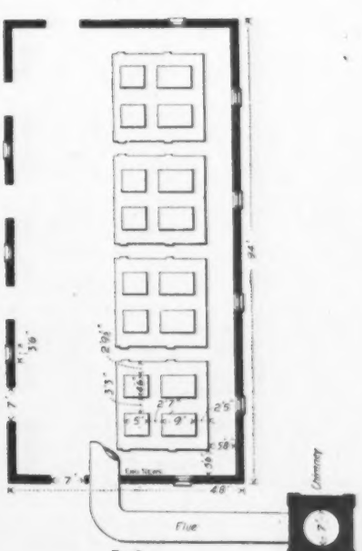


Fig 10.

Figs 10 and 11. Section and Plan of Boiler House.

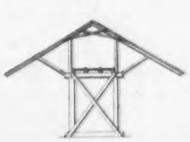


Fig. 13. Section of Coal Shed.

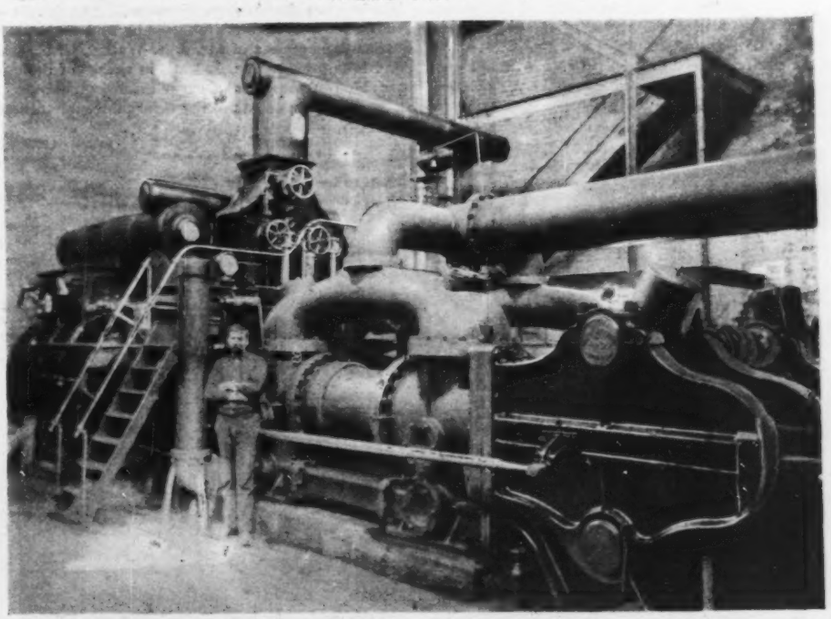


FIG. 15. VIEW OF 5,000,000-GALLON WORTHINGTON HIGH DUTY PUMPING ENGINE IN PLACE.

their inclination; at midstroke they exert no effort on the plunger rod, and during the latter portion of the stroke they are acting in conjunction with the steam end to overcome the water pressure.

Such, concisely, is their construction and action. The advantages claimed are: First, That they make it possible to preserve all the smoothness of action resulting in a constant and uniform flow of water peculiar to the duplex system; second, in their function of transferring power from the early to the latter portion of the stroke, they make possible high steam pressures and corresponding grades of expansion and economy. They are entirely independent of the piston speed of the engine, and consequently are equally effective at all speeds. The cut-off valves are so arranged that steam may be cut off at any point of stroke and at different points on each cylinder independent of the other. Ordinarily they are set so as to cut off on the high pressure cylinders at 15 1-2 and on the low pressure at 22 ins.

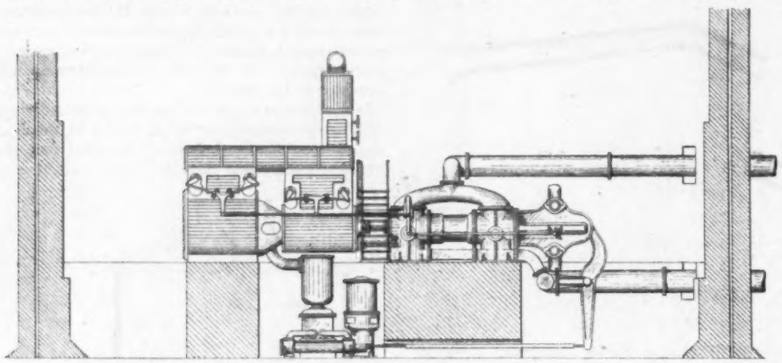


FIG. 14. ELEVATION OF PUMPING ENGINE

The boiler house is 48x94 ft. Boilers, eight in number, are of the return tubular type and are of steel, made in two sheets, 60 ins. in diameter, 16 ft. long, with 44 4-in. tubes in each.

Coal is taken from a coal mine owned and operated by the company half a mile away, and is delivered in trains hauled by mule power and dumped from a trestle in front of the door at an estimated cost of less than $1 per ton. I suppose that no other water company in the United States owns its own mine and mines its own coal, and few, if any, companies obtain their coal so cheaply. (*) The coal lands now owned by the company are estimated as sufficient to last a century. The location of the mine, across the river, is shown in Fig. 5, and the tramway at the river crossing in Fig. 9.

From the pump house to the top of the hill, 2,700 ft. distant, and 385 ft. elevation, it is designed to have a separate force main for each pump. One 20-in. pipe is already laid and another 20 or 24-in. will be laid when another engine is put in. From the top of the hill to the reservoir the line is 30-in. pipe.

There are two reservoirs, only one of which has been completed. They are made as shown by Figs. 5 and 6, by earth dams built across the valley. A 30-in. pipe connects the two and a 30-in. pipe is laid from the larger one, which is nearest the pumping station, through the middle dam and under the bottom of the smaller one, and through the outer dam, so that the supply can be drawn from either reservoir. A second 30-in. pipe was laid under the upper dam, the one nearest the city, with a view to its extension to the city at some future time. A 30-in. pipe is laid around the reservoir and connected with the city supply main for pumping direct.

The flow line of the smaller reservoir is at the 425-ft. contour, at which its area is five acres and its capacity 28,500,000 gallons. Its slopes are paved with sandstone. The larger reservoir at the contour 410, to which the dam has been finished, has a capacity of 63,500,000 gallons, and covers an area of 13.2 acres. All the embankments are constructed of clay of uniform texture throughout in layers of about 6 ins. thickness without any center puddle or masonry wall. The material was sprinkled and rolled in the usual manner with a grooved roller. The slopes are 2 to 1.

From the reservoir the pipe line is nearly straight to the south portal of the tunnel under Red Mountain. It cuts the ridges nearly at right angles and one of the ridges is passed by a short tunnel 150 ft. long. The line passes under Red Mountain by a tunnel 2,000 ft. long, the grade line being 196 ft. below the summit. In rock the section is 7x12 ft. Fig. 16 shows a section of the tunnel in earth, and Fig. 17 a section in rock.

The pipe line from the reservoir to the north end of the Red Mountain tunnel, laid with a grade of 1 1-2 to 1,000, is 30 ins. in diameter. Thence a 24-in. pipe is extended to the intersection of 22d street and 1st avenue, near the center of the city, where it connects with a 16-in. and other mains from the old reservoirs. The new reservoirs are at an elevation of 425 ft. above datum,* while the old one is at 340. In order to use the two in connection the pressure from the higher reservoir is reduced by two regulators so arranged that the high pressure is turned on automatically by the fire alarm apparatus in case of fire, as is described below.

A A, in Fig. 18 are two 16-in. pressure regulators placed in by-passes on either side of the 24-in. main leading from the higher (Cahaba) reservoir. B, in Figs. 18 and 19, is a 24-in. gate with hydraulic lift. C C are gates for shutting off the regulators when necessary. D is a four-way cock for admitting pressure to the cylinder E of the 24-in. gate through the pipes F and G. K is a waste pipe, and I is the supply pipe, which is tapped into the 24-in. main above the 24-in. gate B. N is a cylinder in which a piston is raised by water pressure admitted through the pipe L. To this piston is attached the weighted arm P, which moves the lever or handle O to cock D. The 1 1-2-in. pipe L extends to the nearest firemen's station, 3,800 ft. distant, where the pressure from the street mains is admitted into it when the pressure is wanted. The details of the device thus far were designed by and constructed under the direction of Mr. J. S. Walker, C. E., who had been prior to Jan. 1, 1891, in charge of the construction of the Cahaba River extension.

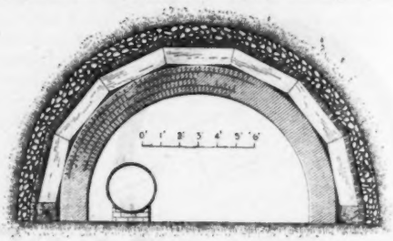


Fig. 16. Section of Pipe Line Tunnel in Earth.

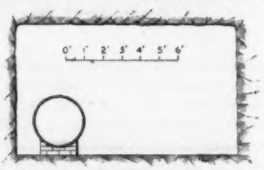


Fig. 17. Section of Pipe Line Tunnel in Rock.

It was expected that the firemen would turn on the pressure to the pipe L whenever fire pressure was wanted, and a cock was arranged for this to be done by hand. But the firemen refused to do this, claiming that it was no part of their duties to do so. In order to remove this objection, the writer designed and placed in the firemen's station the contrivance shown by Figs. 20 and 21, and the view from a photograph, Fig. 22, by means of which the electric fire alarm itself is made to turn on the fire pressure automatically without the assistance of the firemen.

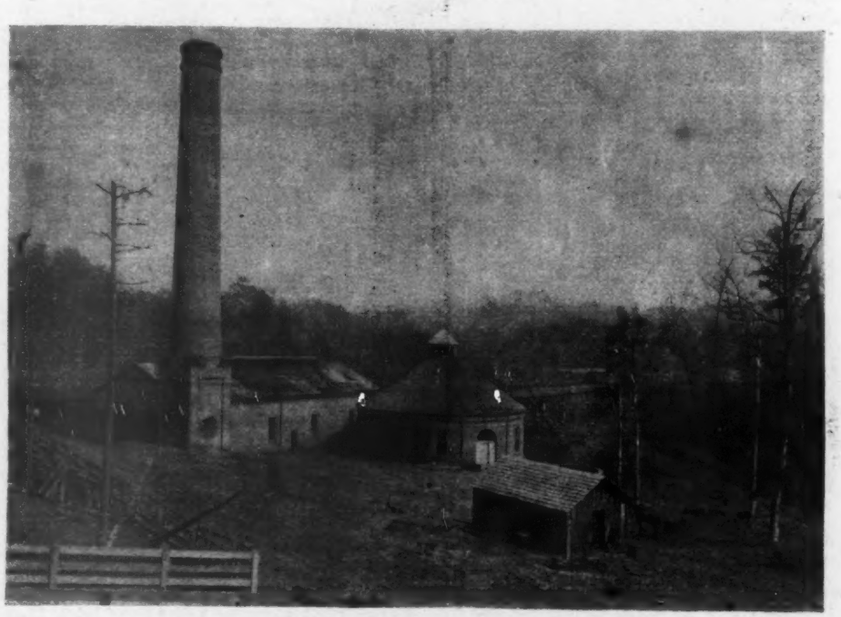


FIG. 9. VIEW OF CAHABA RIVER PUMPING STATION.

(*) Some coal and iron companies, in Pennsylvania, operate water-works in connection with their mines, and the villages in which their employes live, but we know of no other instance where a water company operates a coal mine merely to supply fuel to its pumping station.—Ed.

* Datum referred to in this description is 100 ft. below city datum, which is taken as 100 ft. below the railway track at the Union Passenger Station. Flow line of smaller Cahaba Reservoir (425) is therefore 225 ft. above tracks at Union Passenger Station.

B is the supply pipe tapped into the nearest street main. L is the extension of the same pipe through the three-way cock A to the cylinder N, Figs. 18 and 19, 3,800 ft. distant. C is a waste pipe. D is the lever or handle to the three-way cock A. E is a trigger which holds this lever down in a horizontal position, at which position the supply pipe B is closed and the pressure kept off of the pipe L. I is a weight attached to the electric fire alarm apparatus.

The operation is as follows: Ordinarily the 24-in. gate B, Fig. 18, is kept closed, thus forcing the water through the regulators A A, which reduces its pressure so as to admit the flow of water from the lower reservoir. When the fire alarm is sounded at the station, it trips the weight I which turns the horses loose in the usual manner, and also falls through the guide box F, trips the trigger E, releasing the lever D, which is then pulled over by the weight G. The stop K on the pipe C prevents it from going too far and holds it in a vertical position, closing the waste pipe C and opening the supply pipe B L, through which the pressure is transmitted to the cylinder N, Fig 1. The spiral spring H relieves the shock of the falling weight G and prevents any injury to the apparatus.

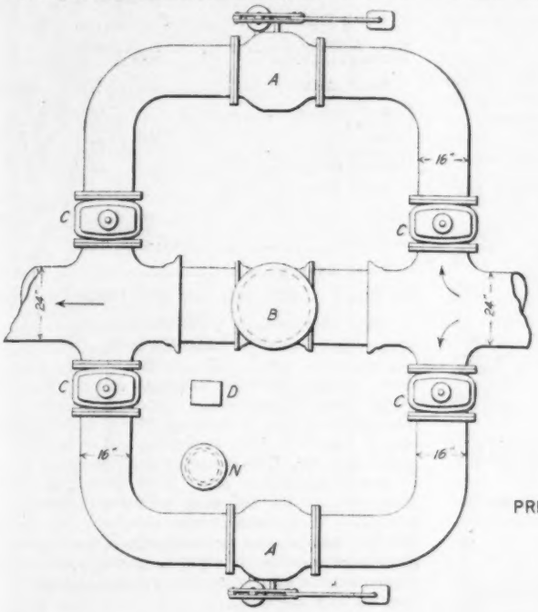


Fig. 18.

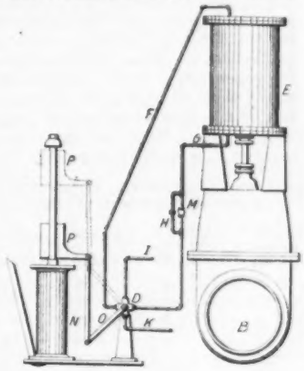


Fig. 19.

PRESSURE REGULATORS ON 24-IN. MAIN.

The pressure thus admitted to the cylinder N, Fig. 1, raises the arm P to the position shown in the dotted lines, reversing the four-way cock and admitting the pressure through the pipes F I to the cylinder E of the 24-in. gate, which it opens and allows the water to pass through straight pipe without having to pass through the regulators A A. Check valves in the mains near the lower reservoir, situated on the opposite side of the city, prevent the water from flowing back into it, and the full pressure due to the elevation of the higher reservoir is given in the city mains.

When the fire pressure is no longer wanted, the lever D, Fig. 20, is pulled back to its horizontal position and the trigger E reset. This removes the pressure from the pipe L and opens the pipe C, Fig. 20. The weighted arm P, Fig. 19, then forces the piston back to the bottom of the cylinder, the water escaping through the pipe C, Fig. 20. This again reverses the four-way cock D and closes the 24-in. gate B, again forcing the water through the pressure regulators A A.

When first put into operation a disk with a 1-4-in. opening was placed in the waste pipe K, Fig. 19, to prevent too rapid opening and closing of the 24-in. gate. This sized opening required eight minutes to open and the same time to close the gate. The fire department demanded that the pressure should be on inside of four minutes. Furthermore on several occasions with this small opening the gate stuck in its seat. In order to remove this objection and at the same time prevent the gate from closing too rapidly, in which consisted the greater danger, I substituted a 1-4-in. for the 1-8-in. disk in the pipe K, Fig. 19, and placed in the pipe G, the by-pass and a check valve M. When the water is passing into the lower side of the cylinder E, lifting the 24-in. gate, the check valve M raises and allows the full area of the pipe. But when the water is passing out of the lower end of the cylinder, that is when the gate is closing, the check closes, forcing the water through the by-pass in which is placed H, a disk with 1/8-in. opening. The gate is thus made to open so as to give full pressure inside of four minutes from the time the fire alarm sounds, while it requires from ten to twelve minutes to close after the pressure is taken off the pipe L.

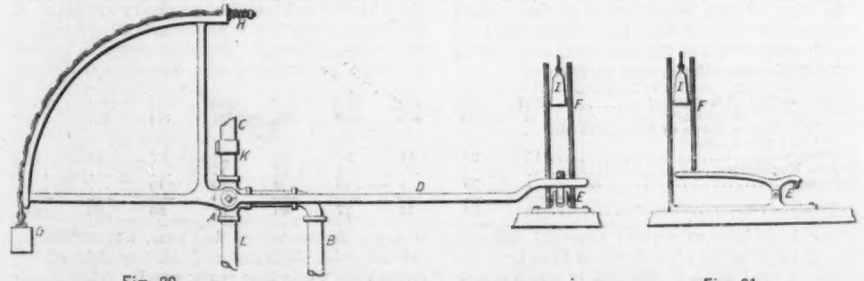


Fig. 20. Fig 21.

PRESSURE REGULATOR AT FIRE STATION.

This device has been in operation now about 13 months and has accomplished the purpose for which it was designed very efficiently.

The following is a summary of the pumping machinery now in use:

North Birmingham, old works, Station.

Two Blake duplex compound condensing engines: cylinders, steam, 28 and 14 ins.; water, 14 ins : 24-in. stroke; capacity, 2,500,000 gallons each.

One Dean duplex compound condensing engine: cylinders, steam, 22 and 40 ins.; water, 23 ins.; 36-in. stroke. Capacity, 6,000,000 gallons.

Four return tubular boilers, 16 ft. long, 60 ins. diameter, with 46 4-in. tubes.

Two B. & W. boilers, 60 and 90 HP., respectively.

Cahaba Station.

One Worthington high duty pumping engine: cylinders, steam, 28 3-4 and 57 1-2 ins.; water, 19 1-4 ins.; 48-in. stroke; capacity, 5,000,000 gallons.

Eight return tubular boilers, 16 ft. long, 60 ins. diameter, with 44 14-in. tubes.

There are in use of all sizes 64.87 miles of mains, on which are located 238 fire hydrants in the city and suburbs. The daily consumption of water for January, 1892, was 6,131,475 gallons.

Mr. J. S. Walker, C. E., had charge of the construction of the Cahaba extension, and was assisted by Messrs. A. D. Edwards, Robert Lee Johnson and H. K. Milner. The drawings accompanying this description were made by Mr. A. D. Edwards, and the photographs from which the views were drawn were taken by Mr. Charles H. Caldwell, an amateur and also stockholder of the company.

The present officers of the company are: James T. Woodward, president; P. H. Earle, vice-president; W. J. Milner, superintendent; C. R. McCullough, secretary; John London, treasurer; L. P. Worl, auditor.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

V.

(These papers will be republished in book form, and corrections or proper additions are solicited, and can be made at any time. It is especially desired to make the list of schools claiming to be engineering schools absolutely complete.)

WEST POINT AND WILLET'S POINT.

How much less stringent the scholastic requirements were in early days than they are now, is shown almost at a glance by the following Table VI., which also shows the exceptionally severe process of winnowing to which the cadets are subjected before they are allowed to gain what is considered the great prize of the course, a commission in the Corps of Engineers. Taking only the totals of admissions for the seven years, 1880-86 (which brings us down to the graduates of 1890, the last class of which we have full records), 751 cadets were appointed, of whom only 29 won the prize of a commission in the Engineers. The entrance examinations winnowed out 25 per cent. of them, the medical examination 3 per cent. of them, and 15 per cent. failed to report for some other reason, after their appointment, mostly (we infer) because of the discovery by themselves or others that they could not possibly meet the requirements. Thus, of those who sought

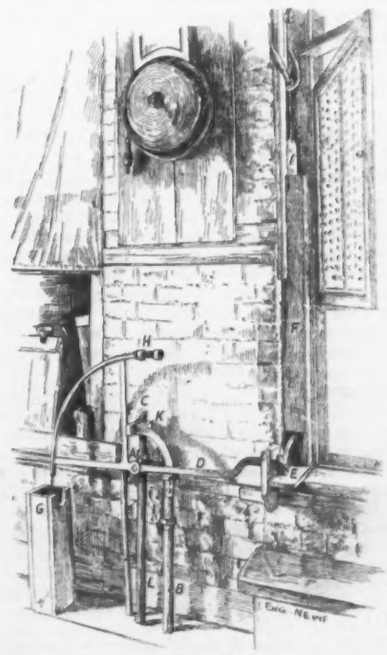


Fig. 22.

and secured appointment, only a little over half (57 per cent.) were permitted even to enter the course, and of these, a little over half again (52 per cent.) were dropped out during the course for deficiency in studies or conduct, * leaving only 28 per cent. of the original appointments to graduate. Of these graduates only 1-12, or 2.2 per cent. of the original appointments, were permitted to enter the Engineers.

Where, in any civil engineering school, will be found a parallel for such a winnowing process as this, or any approach to it? It is to be remembered that all the usual motives for dropping out of a civil college course are absent. The men all stand on a perfect equality in means, and those means are ample. The pay of a cadet is $540 per year; he is not allowed to receive or expend any more, and his pay is graduated so as to meet every proper expense and leave a small fund over for his use at graduation. He is not tempted to leave by some offer of employment, for a life engagement is open to him as soon as he graduates, and for the first four years after graduation he is under pledge to seek no other. Did these two conditions obtain at civil colleges, as now conducted, all but a very small percentage of those who entered would obtain their degree of Civil (or other) Engineer, whereas only 2 per cent. now reach that goal at West Point.

On the other hand, appointments in the Corps of Engineers are specially sought for, not so much because of special taste for engineering, but because it is a "softer" appointment, keeping a man in civilized regions instead of out on the plains, and largely relieving him from military routine, as well as entitling him to a commission as Captain after 14 years' service, provided he passes the necessary examinations. These latter are said to be rigid, but after all they are mere "pass" examinations. If an officer fails once he has another chance, and it is so rare as to be almost unheard of that a man should lose his right of promotion when it comes to him from any lack of knowledge or professional capacity, apart from such offenses as courts martial take cognizance of, which latter, it is but just to add, are very rare in the Corps of Engineers.

Moreover, few civil engineers would think there was anything very "soft" in attaining after 14 years of service as an engineer the emoluments which appertain to a Captain, which are $150 a month, with $24 per month in commutation of quarters if not furnished to him; $15 per month increase for each 5 years' service up to 20 years, and retiring pay of three-quarters full pay. In the Army Register for 1890 the senior Captains of Engineers had graduated in 1867, 23 years before, and the juniors in 1879, 21 years before. Considering the training, duties and age of these officers, they certainly cannot be considered over-paid, and the right to a captaincy after 14 years' service is a very moderate concession.

Too frequent appointment of men to branches of the service for which they have no natural aptitude is checked, however, by another fact. The custom of the academy is, and has always been, to give to a certain number standing near the head (6 in the class of 1891) the privilege of entering any branch of the service they please; to a certain number below these (8 in 1891) the privilege of entering any branch but the Engineers; to a certain number below these again (17 in 1891), the privilege of entering the Artillery, Cavalry or Infantry, and to the last half of the class, or thereabouts, the choice of Cavalry or Infantry only, which choice they exercise in the order of their rank, so that those near the foot of the class have infantry appointments only open to them. When they have the right to do so, however, they nearly always enter the Engineers.

Table VI.—Showing by Decennial Periods the Number of Cadets Appointed, Rejected, Graduated and Admitted to the Corps of Engineers. Also the Percentage of Each out of Each 100 Men Appointed.

	1838-9 2 yrs.	1840-49 10 yrs.	1850-59 10 yrs.	1860-69 10 yrs.	1870-79 10 yrs.	1880-86 7 yrs.
Appointed	223	1,036	1,029	1,074	1,750	1,308
Rejected by Ac. Board	4	70	118	170	564	321
Rejected by Medical Board	2	27	34	21	65	37
Appt. canceled	1*	1	4	3	11	5
Appt. declined	7	15	14	24	33	11
Failed to report	22	54	52	78	129	182
Total rejected	36	167	222	296	802	556(a)
Admitted	187	869	807	778	948	751(a)
Graduated in	(1842-3)	(1844-53)	(1854-63)	(1864-73)	(1874-83)	(1884-90)
	95	425	389	489	512	364
Of which, into Engineers	12	42	80	64	28	29

(a) An unexplained discrepancy of 1 exists in the table on p. 8 of the "List of Cadets," etc., in the line for 1882, which, perhaps was not detected because a compensating but correctible error of 1 existed in the same table for the year 1876.

PERCENTAGES.	1838-9	1840-49	1850-59	1860-69	1870-79	1880-86
No. admitted taken as	100	100	100	100	100	100
Rejected for deficiency:						
In academic exam.	2	7	11	16	32	25
In medical exam.	1	3	3	2	4	3
Appt. cancelled, declined or neglected	13	6	7	10	10	15
Admitted	87	84	79	72	54	57
Graduated	43	41	38	45	20	28
Admitted to Corps of Engineers	5	4	8	6	1.6	2.2

The steady increase shown in Table VI. in the percentage of rejections from 1838 to 1879, is very notable, considering that all the time the stringency of the entrance examinations has been increasing, and also the care used in appointing candidates. Formerly the right of nominating candidates was regarded as a personal perquisite of congressmen, for the most part. Of late years the pressure for appointments and the spirit of the age has made it a common practice to appoint only after competitive examinations. The decrease since 1879 in the percentage of rejections is doubtless chiefly due to this cause.

The class of 1891 was the 90th graduated from the school. In each of these nine decades the total number graduated, and the total number appointed to the Engineering Corps, was as follows:

Decade ending with class of	1811	1821	1831	1841	1851	1861	1871	1881	1891
Total number of graduates	71	214	376	449	425	431	444	521	518
Appointments to Corps of Engineers and its two allied corps:									
Engineers	15	20	14	20	23	24	67	26	44
Topog. Engineers	..	1	...	1	13	17	...	...	...
Ordnance	..	18	...	6	9	20	19	...	...
Total	15	39	14	27	45	61	86	26	44

There have been at various times 13 different corps of the army into which cadets have been appointed on graduation, in addition to which a few graduates (10 in all) have not been commissioned for one reason or another; in many cases because of physical disabilities developing after admission to the academy. These corps, the years when appointments were made to them (only four of them now exist), and the total number of appointments to them from the foundation of the academy to the present time (March, 1892) were or are as shown in the table in next column.

We have classed the Ordnance with the Engineer Corps for the reason that it is a scientific corps to which appointments are greatly sought. At to which appointments were greatly sought. At present officers are not appointed to this corps from West Point, but from the army by competitive examination after two years' service.

Calling the Ordnance an engineer corps, it will be seen that about 10 per cent. have been commissioned as Engineers; about 31 per cent. have been appointed to the Artillery; about 19 per cent. have been appointed to the Cavalry, and about 40 per cent. have been appointed to the Infantry. In the last five years, 1887-91, inclusive, the proportions have been: Engineers, 7 1-2 per cent.; Artillery, 19 per cent.; Cavalry, 23 1-2 per cent., and Infantry, 50 per cent., showing a sensible decrease in the percentage of appointments to the two higher branches of the service.

Corps	Years when appointments were made.	Total No. appointed.
Engineers	Foundation to date	253
Topog. Engineers	1818; 1839-1861	32
Ordnance	1815-20; 1839-68	72
Total, Engineers		357
Light Artillery	1808-20	49
Artillery	1803 to date	1,025
Total, Artillery		1,074
Light Dragoons	1809	1
Dragoons	1834-61	136
Cavalry	1855 to date	455
Mounted Rifles	1846-1861	35
Mounted Rangers	1832	5
Total, Cavalry		632
Infantry	1806 to date	1,366
Rifles	1820; 1843	5
Marines	1814; 1817; 1825	5
Total, Infantry		1,376
Not Com.	1811, 1828, 1854, 1869, 1880-81	10
Total, graduates	1802-1891 inclusive	3,449

The requirements for admission to West Point are nominally low, only reading, writing, spelling, arithmetic, English grammar, geography and the history of the United States, but the examinations are rigid. The candidate must be between 17 and 22 years of age, at least 5 ft. high, unmarried and of perfectly sound physique. The course of study to-day is not so greatly changed on paper from what it was 50 years ago, as the following comparative abstract will show. In practice a higher standard of scholarship is demanded, and the cadet who enters with no previous knowledge of algebra, geometry or trigonometry must have more than average capacity to keep up with his class.

In 1841 as in 1891, cadets began and finished (as separate studies) algebra, geometry and trigonometry in the first year. The second year they began and finished calculus, shades, shadows and perspective, and analytical and descriptive geometry. The third year they began and finished mechanics and astronomy. The fourth year only they take up distinctively engineering studies. The instruction in drawing extends through the second and third years; in French, through the first and second; in Spanish (a modern innovation), through the fourth year. Specific instruction in surveying is given only the first year. Physics, chemistry, mineralogy and geology are taught chiefly in the third year. Law, history and historical geography are taught in the fourth year; they were formerly hardly touched on. A quite thorough "finishing" course in English grammar, history, geography, rhetoric and the like is now a feature of the first year, which formerly did not exist. Infantry and artillery drill extend through the whole four years; cavalry drill through the last three years only. All the four classes take part in frequent parades and battalion drills.

The course as thus outlined does not differ very materially from that at ordinary engineering schools, except that a tremendous amount of mathematical drill is crowded into the first year, owing to the lower standard for admission.

All graduates of West Point who receive commissions in the Engineers, however, are required to take a 2 1-2 years' post-graduate course at the "United States Engineer School" at Willet's Point, N. Y., on Long Island and Long Island Sound. This school, formerly called the "Engineer School of Application," has existed in an informal way for 20 years or more, but was reorganized into a more permanent and formal school in 1885. The Battalion of Engineers (except one company at West Point) is stationed here, and usually numbers about 400 men. They are the only troops drilled in torpedo defense, and they are very thoroughly drilled.

* Cadets are dropped almost invariably for deficiency in mathematics, if we may judge by the dismissals recorded in the Register for 1891, in which the dismissals seem to be rather fewer than usual. After the 1891 examination there were dropped from the

First (graduating) class, of 65 examined	None.
Second class of 63 (for def. in mechanics)	1
Third class of 56 (all for def. in mathematics)	5
Fourth class of 76 (all but 3 for def. in math.)	11

In addition to the above 16 men dropped, there had been dropped from the third and fourth class at the preceding June examination, or at other times during the year, 33 cadets, making an even 50 in all dropped during the school year 1890-91.

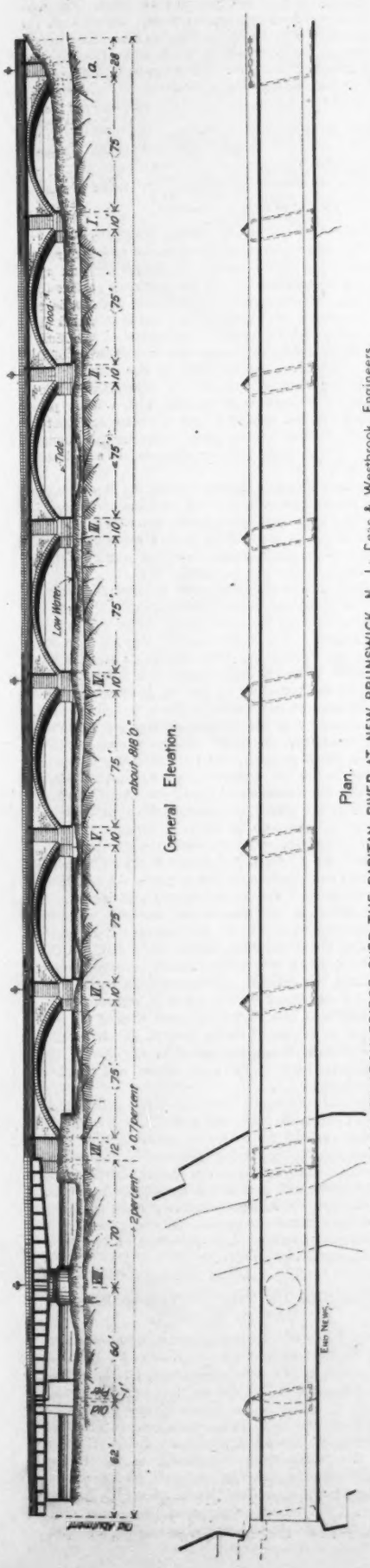


FIG. 1. MASONRY ARCH BRIDGE OVER THE RARITAN RIVER AT NEW BRUNSWICK, N. J. Dean & Westbrook, Engineers.

To give such drill was the primary purpose of the school, but being needed for this use, advantage was taken of the fact to afford practical post-graduate instruction to officers in military and civil engineering, electricity, astronomy, surveying and photography.

The course for officers covers 91 weeks in all, the distribution of time being about as follows:

Submarine mining, torpedo practice	40 weeks.
Chemistry, military photography	19 weeks.
Military engineering	10 weeks.
Civil engineering	22 weeks.

It is of course highly important that all engineer officers should be thoroughly trained in torpedo work, but that is an excellent preliminary training for any kind of river and harbor work, toward which the time allotted to civil engineering is chiefly directed.

When the young officer has finished his post-graduate course, after going through the severe and long-continued sifting process at West Point, he ought certainly to represent a much higher average of natural engineering ability, and of scholastic acquirements as well, than the average graduate of any civil engineering school. The trouble is, if trouble there be, that thereafter he does not have to endure that life-long sifting process in the struggle for existence and for recognition by which the poorer material drops out, and the better rises to the top, while the faculties of the better men and poorer men alike are developed to the utmost by the stimulus of necessity and professional ambition. There is something of this in the Corps of Engineers, of course, but very little. Let a man be never so bright he cannot rise but so fast. He has to wait his turn. Let him be never so poor an engineer, and when his turn comes, up he goes, after passing the examinations before noted.

There is indeed within the corps a certain choice exercised, and a certain field for professional competition, in respect to the assignments to duty. But this field is comparatively so narrow that the West Point graduate in engineering is under very different conditions throughout life from his fellow in civil life. Very naturally his training must also be different, and the requirements for obtaining a footing in the corps must be more severe, in order to maintain a proper standard of efficiency, and prevent so far as possible the entrance of poor material into the corps.

For this reason the courses and conditions at West Point cannot profitably or fairly be compared with those which exist at non-military engineering schools and we have considered it by itself. The other engineering schools we shall consider collectively and not separately, taking up one phase after another of the general question of technical education, rather than one school after another. The only exception to this will be in respect to some notes of the earlier history of some of our first engineering schools, which we will now proceed with.

THE ALBANY ST. MASONRY ARCH BRIDGE.

We show in the accompanying engravings the general elevation and plan, and cross and longitudinal sections of one of the arches of the masonry arch bridge to be built to carry Albany St. over the Raritan River and canal at New Brunswick, N. J. The bridge was designed by Dean & Westbrook, 136 Liberty St., New York city, who are also the contractors for its construction, and to whom we are indebted for the plans from which the drawings for the illustrations were made. The total length of the structure will be 818 ft., and it will consist of seven masonry arches of 75 ft. span each, an iron swing span of 130 ft., and a plate girder span of 62 ft. There will be a 25-ft. roadway and two sidewalks 5 ft. 6 ins. wide each. The entire bridge will be on a skew of 80 degrees, and the roadway of the masonry arches will have a grade of 0.7 per cent., and that of the iron swing span and fixed span a grade of 2 per cent. The contract price is $99,000.

The principal point of interest is the design of the arches. They are of brick with ring courses of granite, and have a rise of only 15 ft., or one-fifth of the span, which is unusually small for this class of masonry. The brick are laid in a bond of five courses of stretchers to one course of headers, the excess in length of the extrados over the intrados being so small as to require no special bond to provide for the effect of the curve of the arch upon the joints. In calculating the strains on the masonry the horizontal thrust at the crown was taken at 36,000 lbs., and the reaction at the skewbacks is given as 56,400 lbs. This gives a pressure on the brick at the crown of 100 lbs. per sq. in., and on the brick at the skewback of 105 lbs. per sq. in., which assuming the crushing strength of brick masonry at 1,770 lbs. per sq. in., leaves a factor of safety of 15.2. The principal dimensions and details of the arches are shown in Fig. 2.

The general provisions of the specifications are as follows:

All excavations for piers shall be carried down to rock, as shown on engineer's profile, and may be made by dredger or otherwise. The foundation pits shall be inclosed by cofferdams and the foundations of large quarry stone shall be carefully laid in quick setting Portland cement, and sand mixed in proper proportions. The piers shall consist of coursed masonry of Stockton stone rock-faced, laid alternately header and stretcher, with courses not less than 15-ins. thick and with dressed beds and risers and a ½-in. chisel draft. The beds shall be not less than the thickness of the courses, and the vertical joints shall be dressed not less than 8-ins. The stretchers shall be not less than 3½ ft. long.

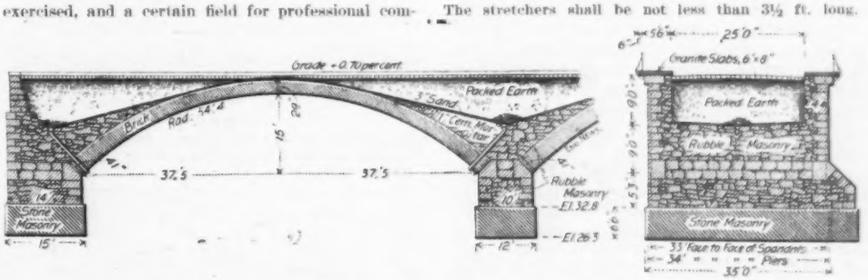


FIG. 2. DETAILS OF ARCH.

The stretchers shall be at least as broad as they are thick, and 2½ ft. long. The center portions of the piers shall be filled either with first class rubble masonry, or with concrete carefully rammed in place. The piers shall be provided with ice-breakers, as indicated, with stone faces dressed down to ¾-in. projections.

The skewbacks shall be of Stockton stone of such thickness as to take the whole bearing of the arch in one stone and shall be dressed to a bed of 3 ft. The springing line shall be dressed truly radial to the curve on the arch and vertical to the axis of the bridge. All pier masonry and skewbacks shall be laid in best quality of hydraulic cement and shall be thoroughly pointed with Portland cement mortar.

The arches shall be laid in first class quality of hard burnt brick, and of such thickness as indicated in the drawing. They shall be laid in bonded courses of five courses of stretchers to one course of headers, in full mortar beds and thin joints. The ring courses on each outside shall be 2 ft. thick and alternately 1½ ft. and 2 ft. long. They shall be of granite, rock-faced, with 1-in. chisel draft and dressed intrados. All arch masonry shall be laid in best quality of hydraulic cement mortar and the joints shall be properly pointed after removal of centers.

The spandrel walls shall be laid in coursed masonry, rock-faced with ¾-in. chisel drafts, with beds dressed 1¼ times the thickness of the courses and vertical joints dressed back 6 ins., and every third stone a stretcher of at least 2½ ft. long. The top shall project 1 ft. beyond the face of the spandrel wall, and shall reach back and rest upon the wall 2 ft. It shall be dressed on top a distance of 6 ins. to give a bearing to the flagging of the sidewalk. All spandrel masonry shall be laid in cement mortar and shall be properly pointed.

All backing of the arches shall be of rubble masonry laid in cement mortar and of such thickness as indicated on the plan. It shall be graded so as to drain toward the waste pipes provided over each pier. The whole upper surface of the exposed arches and of the

backing and of the sides of the spandrel masonry shall be carefully plastered over with a 1-in. layer of hydraulic cement mortar. Upon this cement covering of the arches and backing, a 3-in. layer of gravel shall be placed to carry off the water which may filter in from the top, and the mouths of the waste pipes over the piers shall be properly protected by cast iron or terra-cotta screens. All back filling above the gravel shall be of earth well rammed in layers to the level of the subgrade of the pavement of the roadway.

The Belgian pavement of the roadway shall consist of blocks of trap rock 6 ins. thick, resting on a 3-in. layer of clean sand. Paving shall be done in the usual manner with full sand joints between the blocks. The sidewalk flagging shall be of granite, as shown on plan, and it shall rest upon the top course of the spandrel wall.

PUMPING ENGINE TESTS AT LOWELL, MASS.

In our issue of Feb. 20 we reported the principal results of a test of the new high-duty Worthington pumping engine at Lowell, Mass. The complete report of the test, together with tests of two other pumping engines in the Lowell pumping station, has just reached us. The test was made by Mr. George H. Barrus, M. E., on Feb. 11 and 12; and was conducted in accordance with the standard code adopted in 1890 by the American Society of Mechanical Engineers. A notable departure in this code is that the duty is stated in foot pounds per million heat units in dry steam delivered to the engine. This unit was adopted partially to avoid combining the duty of the engines with that of the boilers. It corresponds pretty closely to the generally used unit of 100 lbs. of coal. If the coal used evaporates 10.36 lbs. of water from and at 212 degrees F. per lb. of coal, the heat units delivered to the engine will be exactly 1,000,000 per 100 lbs. of coal burned.

The Worthington high-duty engine has been described and illustrated in our issues of Aug. 17 and 31, 1889, and its construction is now so familiar to most hydraulic engineers that we need not describe it again. The principal dimensions of the Lowell engine are as follows:

Cylinder diameters: h. p., 25 ins., l. p., 50 ins.; water,	27 1-2 ins.
Stroke, maximum length	38 ins.
Minimum cylinder clearance, h. p., 2%; l. p.,	1.5%
Ratio of volumes h. p. cyl. to l. p. cyl.	1 to 4.15
Pipe diameters: steam pipe, 6 ins.; suction and force mains,	30 ins.
Elevation of crest of weir above average water line in pump well during test	155.5 ft.

The steam cylinders are jacketed on sides and heads with steam from the boiler, and in passing from the high-pressure to the low-pressure cylinder the steam passes through a reheater. The steam for the reheater is taken from the drain pipe of a steam separator attached to the engine, and it passes from the reheater through the jackets of the four cylinders. The condensed water drains to a tank, from which it is returned to the boilers by a small duplex pump working automatically. The main steam pipe from the boilers to the engine is 146 ft. long, and is lagged with magnesia. Besides the separator attached to the engine, a Stratton separator is placed on the main steam pipe close to the engine. The steam cylinders are lagged with magnesia, outside of which is a layer of hair felting covered with black walnut lagging.

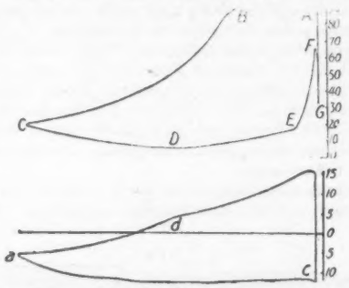
Steam for the engine is supplied by two new horizontal return tubular boilers, set in brickwork with hollow side walls. Shaking grates with about 40 per cent. of air space are used. The flue gases pass into an overhead brick flue, thence to the rear, and finally descend by a brick drop flue into an underground flue leading to the chimney. The overhead flue contains a feed-water heater, consisting of a plain wrought iron shell without tubes, 20 ins. diameter and 16 ft. long. The feed water is pumped from the hot well and passes through this heater on its way to the boilers. The drop flue contains a damper controlled by a Locke automatic damper regulator.

The boilers are 6x16 ft. in size with 140 3-in. tubes. Each has 1,755 sq. ft. of heating surface and 36 sq. ft. of grate surface, a ratio of 48.8 to 1. The ratio of grate surface to combined cross section through tubes is 6.5 to 1.

The duty trial consisted of a 10-hour run, the plant being started long enough before and kept in operation long enough after to insure uniformity in the 10 hours working. The principal results of the trial were as follows:

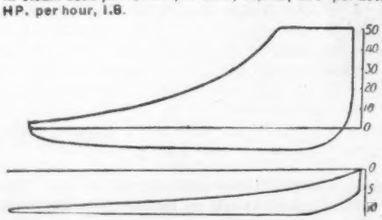
Average length of piston stroke (max. 38 ins.)	37.7 ins.
Temperature of water supplied to boilers by main feed pump	170 deg. F.
Boiler pressure (by gage on steam pipe)	96.2 lbs.
Total pressure against which pump worked	85.06 lbs.
Percentage of moisture in steam	0.38
Mean effective pressure, h. p., cylinders	43.14 lbs.
" " " l. p. "	15.53 lbs.
Duty per 1,000,000 h. u.	16,208,007 ft. lbs.
Capacity per 24 hours by plunger displacement,	11,345,141 gallons.
Capacity per 24 hours by weir measurement,	10,876,008 gallons.
Percentage of slip	4.1 (a)
Revolutions of engine per minute	20.86
Indicated HP. developed, all steam cylinders	402.17
Work done by 100 lbs. of coal (computed for whole time engine was in operation, after correcting for the heat lost by throwing away jacket water)	110,437,241 ft. lbs.
Boiler Test:	
Draft in inches of water	0.14
Temperature of escaping gases	486 deg. F.
" feed water entering flue heater	106 deg. F.
Percentage of ash in coal	8.1
Coal burned per hour per sq. ft. of grate	9.79 lbs.
Water evaporated per hour per sq. ft. of heating surface	2.1 lbs.
Water evaporated per lb. of dry coal	9.55 lbs.
Water evaporated per lb. of combustible from and at 212 deg.	11.64 lbs.
Coal consumed per I.HP. per hour	1.69 lbs.
Total heat of combustion of coal obtained by calorimeter trial	13,361 h. u.

Besides the new engine above described, the Lowell pumping station has a beam and fly wheel compound condensing engine, built by Henry P. Morris, in 1873, and a compound duplex Worthington engine, built in 1875. On Jan. 28 and 29 duty tests of these engines were made on the same plan as that followed in the test of the new Worthington engine.



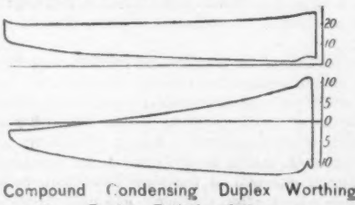
New Worthington High Duty Compound Condensing Engine.

Steam pressure, 96 lbs.; Vacuum gage, 25.9 ins.; Heat units in steam used per I. HP. per hour, 16,562; Lbs. per actual HP. per hour, 1.8.



Old Compound Condensing Beam and Fly-Wheel Engine Built by H. P. Morris in 1873.

Steam pressure, 54 lbs.; Vacuum gage, 2.75 ins.; Heat units in steam used per I. HP. per hour, 23,453.; Lbs. coal per actual HP. per hour, 2.5.



Old Compound Condensing Duplex Worthington Engine, Built in 1875.

Steam pressure, 48.5 lbs.; Vacuum gage, 26 ins.; Heat units in steam used per I. HP. per hour, 32,883; Lbs. coal per actual HP. per hour, 3.7.

INDICATOR DIAGRAMS FROM PUMPING ENGINES OF LOWELL, MASS., WATER-WORKS.

(a) It is believed that the weir measurement did not show the total quantity of water discharged to the reservoir, as it was designed for the measurement of a much smaller quantity of water, and there were reasons for doubting its accuracy. This is corroborated by the fact that an old Worthington engine tested just before, one of the plungers of which is known to have leaked badly, had a slip of only 3 per cent.; and it is improbable that a new engine would have a larger slip.

The duration of the test was 11 hours. The temperature of water supplied to the boilers from the hot well was about 60 degrees less than in the tests of the new engine, which had some influence in lowering the duty. The principal results shown by these engines were as follows:

	Morris engine.	Old Worthington.
Duty per 1,000,000 h. u., ft. lbs.	77,418,178	54,777,009
Capacity, 24 hrs. by plunger, galls.	5,714,639	6,187,887
" " weir, galls.	5,358,949	5,961,554
Slip per cent.	6.2	3.7
Revolutions per minute	12.3	13.45
I. HP. of all steam cylinders	172.12	190.12
Feed water consumed per I. HP. per hour (corrected for moisture in the steam (lbs).	21.7	30.2
Duty per 100 lbs. of coal, ft. lbs.	77,598,096	53,496,046

The boiler test showed results not varying greatly from those given above. It should be said that these two engines were in by no means perfect condition. The low-pressure piston of the Morris engine showed excessive leakage, and it is stated that it had no packing ring. The bucket of the Morris pump leaked so much that the wire drawing of the water could be plainly heard by one standing near the pump barrel. One of the Worthington pump plungers was tested for leakage with a water pressure of 50 lbs. behind it, and a stream sufficient to nearly fill the 1 1-4-in. drain valve leaked through. The Worthington high-pressure pistons also leaked badly.

Sample indicator diagrams from the three engines are shown herewith, and tell very plainly why it is that the high-duty Worthington was able to do more than twice as much work with a given amount of steam as the old Worthington engine, and 2 1-2 times as much as the Morris engine.

The indicator diagrams from the high-duty engine are of somewhat peculiar shape, and it may be of interest to trace the action of the steam through one revolution. The high-pressure diagram is taken from the end farthest from the pump, and the low-pressure from the end nearest the pump. Beginning at the point (A) on the h. p. card, steam at boiler pressure is admitted to the h. p. cylinder, and at the same time the exhaust passage leading to the condenser from the l. p. cylinder is opened (point (a) on the l. p. card). At (B) the steam is cut off from the h. p. cylinder, and expansion occurs through the remainder of the stroke. At (C) (c) both cylinders are placed in communication with the receiver; the pressure in the l. p. cylinder instantly rises to 15 lbs., and both pistons begin the return stroke. At (d) the l. p. cylinder is cut off from the receiver and expands the steam during the remainder of the stroke. The h. p. cylinder still remains in communication with the receiver, however; and as it forces the steam into it, the pressure rises somewhat as the piston moves from (D) to (E). At (E) the h. p. piston covers the exhaust passage leading ing from the cylinder and compression begins. At (F) the movement of the piston is retarded while the valves in the water end seat themselves and there is an escape of steam through the dash relief valve causing the sudden drop in the line to the point (G). Live steam then enters and another stroke begins.

The high-duty engine can use steam with a high ratio of expansion and vary greatly the pressure in different parts of the stroke, as shown by the cards, because the "compensating cylinders" at the rear of the engine store up the power during the first half of the stroke and give it out during the last half. The old style Worthington engine, on the contrary, has to take steam throughout the whole stroke. A better object lesson to show the effect of expansion on economy is seldom seen.

FILTER-BED OF THE WATER-WORKS AT RATON, N. MEX.

A novel type of filter-bed is to be used in connection with the new water-works at Raton, N. Mex., if plans made by Mr. Lewis Kingman, C. E., of Topeka, Kan., are carried out, as they very likely will be.

The water-works at Raton were built in 1881 by the Atchison, Topeka & Santa Fe R. R. Co. In 1891 the works were transferred to the Raton Water-Works Co., which let contracts for a new supply plant to the Gate City Construction Co. In December, 1892, construction, which was then well under way, was abandoned, owing to some financial

complications. It seems probable, however, that the work will eventually be carried out.

The reservoir is designed to store 52,000,000 gallons. It will be formed by a dam 48 ft. high, 360 ft. long and 20 ft. wide on top. The lower part of the dam will be of loose rock and the upper half of earth. It will have slopes of 2 to 1, and the inner slope will be covered with loose rock. There will be a concrete heart-wall 6 ft. thick at the bottom and 4 ft. at the top, and a spillway 6 ft. deep and 110 ft.

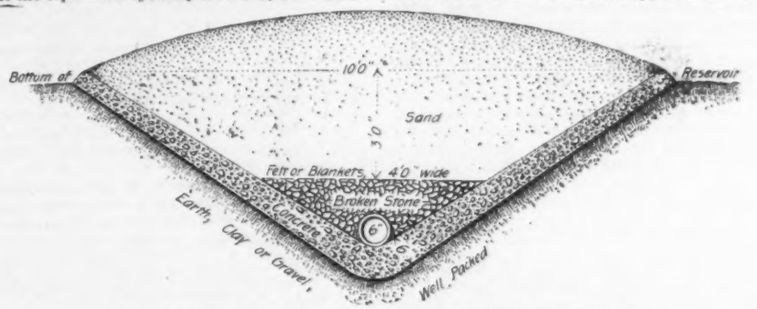


FIG. 2. SECTION THROUGH TRENCH, RATON FILTER BED.

long, excavated in rock. The dam rests on a rock foundation.

Water will be drawn from the reservoir through a 12-in. cast iron pipe, which, together with a 16-in. waste pipe, will be laid in a rock trench, in concrete. A foot bridge will lead from the top of the dam to a gate tower, which consists of a square trestle shown in plan in Fig. 1. The supply main to the town will consist of two miles of 10 and five miles of 8-in. cast iron pipe, designed to deliver 1,000,000 gallons daily, the reservoir being 458 ft. above the town.

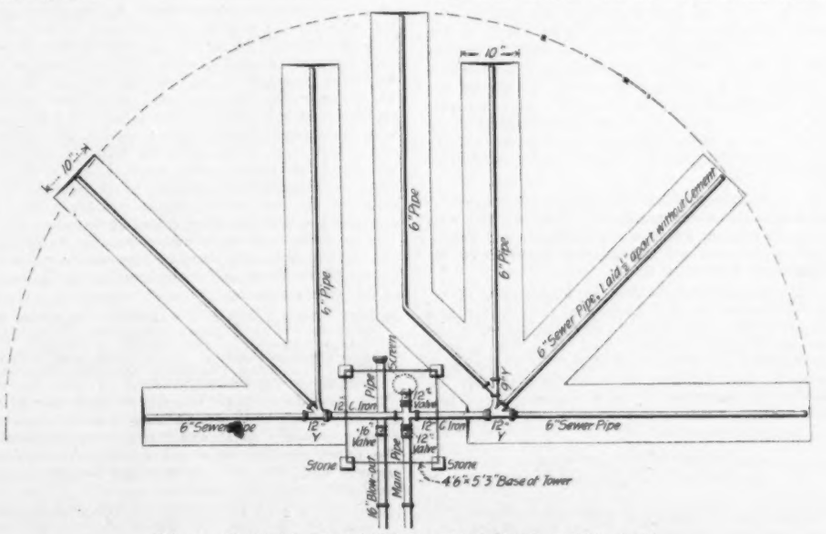


FIG. 1. PLAN OF PROPOSED FILTER BED AT RATON, N. M.

The filter-bed will be located at the foot of the inner slope of the dam, at each side, and in front of the foot of the gate tower, as shown in Fig. 1. The filter-bed consists of several concrete-lined, triangular-shaped trenches, filled with filtering material, as shown in detail in Fig. 2. These trenches are 10 ft. wide at the top and 3 ft. deep at the center, where there is a line of 6-in. glazed sewer pipe laid with 1-2 in. open joints. These sewer pipes connect with the supply main by means of a 12-in. cast iron pipe joined to a four-way special in the main. The sewer pipes connect with each other and the 12-in. cast iron pipe by means of junctions and curved joints of glazed pipe. A valve on the reservoir side of the four-way special permits water to be drawn directly from the reservoir through a screen, if desired.

As will be seen by Fig. 1 the concrete lining of the trenches is 3 ins. wide at the sides and thickens to over 6 ins. at the center.

When filtration is started water will first pass through a bed of sand, rounded to give a depth of 3 ft. at the center, as shown by the cross-section, Fig. 1; then through a layer of felt or cheap woolen blankets, designed to keep the sand from passing into the stone, the trench at this point being 4 ft. wide; then through broken stone to the drain pipe, the broken stone filling an inverted triangle with a base of 4 ft. and an altitude of about 1 ft., but the pipe taking up the apex, which is rounded.

In constructing the filter-bed about 300 cu. yds. of excavation would be necessary, and the following material, not including sand and broken stone, would be required:

72 cu. yds. concrete.
24 ft. 12-in. cast iron pipe.
1 12-in. 4-way cast iron special.
200 pieces 6-in. glazed sewer pipe.
2 junctions 12x6-in. glazed sewer pipe.
1 junction 9x6-in. glazed sewer pipe.
1 curved joint, 9-in. x 1-8 curve.
1 curved joint, 6-in. x 1-8 curve.
400 lin. ft. of felt or cheap woolen blankets, 4 ft. wide.

The total surface area of the filter-bed will be about 3,500 sq. ft. The supply main is designed to carry 1,000,000 gallons of water daily, but probably the consumption will not equal this amount for some time as the population of Raton in 1890 was only 1,255.

Assuming that 1,000,000 gallons is drawn from the reservoir daily through the 3,500 sq. ft. of filtering surface, the rate of filtration would be 286 gallons or 38 cu. ft. per sq. ft. in 24 hours.

Mr. James Kirkwood, C. E., in "Filtration of River Waters," assumed as a fair daily rate of filtration, 89.75 gallons, or 12 cu. ft. per sq. ft. of surface. But this rate is with a head of from 9 ins. to 2 1-2 or 3 ft., while at Raton there will be 40 ft. of water above the surface of some if not all of the filter trenches. It is not known whether the several trenches (see Fig. 1) are on the same level, or whether they are located on benches prepared for them on the slope, but from the plan it appears that some of the trenches have 40 ft. of water above them. In any case, the head will be great, even after allowing for a possible reduction owing to the rate of filtration exceeding the capacity of the supply main, or to the partial closing of the gate in the supply main.

There being no way to clean the filter-bed without emptying the reservoir, it seems sure to become foul between times of cleaning. As originally planned felt was to be used between the sand and broken stone. Mr. Kingman informs us that in place of this cheap woolen blankets will probably be used, so it is not necessary to speculate upon the working of the felt. It seems, at least, quite possible that the blanketing would become objectionable through foulness. The sand with so great a pressure upon it may pack and the water pass without filtration through fissures in the sand or down the sides of the trench, unless the concrete is made quite rough. The concrete might be stepped with advantage.

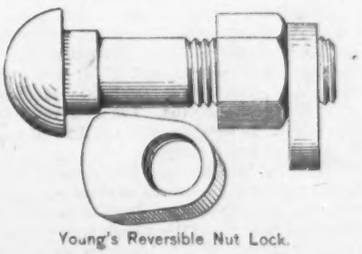
As the reservoir is 485 ft. above the town sufficient head might have been spared for filtration through filter beds constructed outside the reservoir and accessible for cleaning in the usual way, which is by removing a thin layer of sand from the top of the filter as often as it becomes fouled, and when from 6 to 10 ins. have been removed, putting on the same amount of clean sand, or a gravity type of commercial or mechanical filter might be used to advantage. The results obtained from this filter will be of interest.

THE YOUNG REVERSIBLE NUT LOCK.

It seems almost impossible when we consider the many thousands of nut locks which have been invented, that any wholly new idea can still be brought out in this line. The device illustrated in the accompanying engravings, however, is new to us at least, though we are not advised as to the claims of the patent which has been secured on the device. The principle is evident at a glance. The lock is simply a lop-sided nut screwed on outside of the main nut. It acts first as an ordinary jam nut, and, secondly, the weight of the projecting side of the lock tends to turn it on the bolt. The lock is made of a thickness equal to say 3½ or 4½ times the pitch of the threads, so that if, when screwed onto the bolt, it comes into a position in which it tends to turn off instead of on, it is simply taken off and reversed, which changes the position of the lop-side 180 degrees.

Of course, as the lock acts by gravity, it is only of use on a horizontal bolt; and it is intended chiefly for use on track joints. It is claimed as an advantage that the lock is outside of the nut and its pressure tends to relieve the strain on the nut, instead of increasing it, and producing a cross strain, as with the spring locks placed between the nut and the angle-bar. The lock can also be applied to any joint (with bolt having the usual standard thread) without removing the nuts. The lock is

Lock in Position on Rail Splice.



Young's Reversible Nut Lock.

claimed to be made, in large quantities at least, as cheaply as any nut lock in the market.

This lock was invented by Mr. Levi H. Young, Superintendent of the St. John's, New Brunswick, Bolt & Nut Works; and it has been tested principally on Canadian railways. The Intercolonial Ry. has had about 150,000 of them in use for nearly two years, and Chief Engineer Collingwood Schreiber states that they are working satisfactorily, and that he considers it one of the best nut locks which he

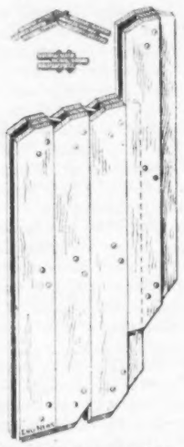
has tried. Besides testimony in its favor from many Canadian engineers, it is now being tried on the New York Central & Hudson River R. R., and on the Manhattan Elevated. In a recent test on the former road, 12 nuts, located where there was exceedingly heavy traffic, were locked with this device and the position of locks and nuts marked. After some months an examination was made and it was found that five locks had not moved, while seven had turned, forcing the nut further on the bolt.

It will be clear that the lock, when screwed up tight by a wrench, locks in two ways; first, on the ordinary jam nut principle, and secondly, by in effect making a compound lop-sided nut, which cannot turn backward without acting against gravity, but is aided by gravity to turn forward and take up any slack which may result from wear, if the slack be great enough to eliminate the frictional resistance. It is claimed that it will in all cases, when properly set in the first place, screw itself up at least tight enough to prevent the bolt rattling.

The lock seems to us to be one of quite sufficient promise to be worth a careful trial. Mr. Ira Abbett, 150 Liberty St., New York, is agent for it.

THE SEEP-WATER PROBLEM AT CAIRO, ILL.

The Cairo "Daily Bulletin" devotes considerable space to an article by Mr. W. P. Halliday proposing a solution of a problem of much import to that



Wakefield Sheet Piling.

water-logged city. Lying as it does at the junction of the Ohio and Mississippi Rivers on low land, Cairo is only protected from overflow in high stages of these rivers by a complete system of levees. These barriers are among the best in construction in the Mississippi Valley, but they do not prevent annoyance by the seepage of water under the levees each time the river water rises above the level of the natural banks.

The prevention of this nuisance is the problem in question. To fill the space within the levees to a plane above high water mark is impracticable, and any partial filling would be useless. But from borings made by the government engineers, the following sequence of soil is found underlying the city: Surface soil, 4 ft.; coarse sand, 3 ft.; fine sand, 8 ft.; sand and gravel, 6 ft., and then alternating strata of blue clay and sand. The river water finds its way under the levee through the 3 ft. of coarse sand, and thus into the city.

Mr. Halliday believes that this seepage can be prevented by cutting a trench through the several sand strata, outside the levee, down to the blue clay stratum, and then filling this trench with a clay impervious to water. But he suggests as a better method still, the driving of sheet piling down to the blue clay in connection with the clay trench, and proposes for this piling of the Wakefield type made of three planks bolted together in the manner shown and forming its own tongue and groove. It has been in successful use for several years in the West, and it is claimed that made of 1-in. boards it can be driven by hand and makes a water-tight joint. This compound pile is said to stand harder driving than a solid pile as it better resists destructive vibration. Mr. Halliday finally recommends this clay trench and piling as the only feasible means of preventing seepage; the filling to grade of all low places within the levees, and the establishment of a pumping station for the removal of rain water and sewage. The work will cost considerable money, but once accomplished, Mr. Halliday thinks that Cairo will soon assume the importance which its geographical position warrants.

Iron and steel manufacture is to be established in China on a modern scale, and a complete plant is being erected, comprising two blast and a rolling mill, with all the necessary appliances for the production of steel and iron plates, bars, rails, etc., and the latest types of Bessemer and Siemens-Martin plant are included. The blast furnaces are nearly completed, and the production of pig iron will soon be commenced, while the rail mill and reversing engines have been recently shipped by the makers, the Teeside Iron & Engine Works Co., of Middlesborough, Eng.

PERSONALS.

Mr. H. M. McIntosh has been elected City Engineer of Burlington, Vt.

Mr. Chester B. Davis, M. Am. Soc. C. E., Chicago, has removed his office to the Monadnock Building.

Mr. John Russell Young has been appointed Fourth Vice-President of the Philadelphia & Reading R. R. Co.

Mr. Ferdinand Destwolinski, a well known mining engineer and inventor, died at Fort Scott, Kan., on April 9.

Mr. C. L. Williams has been appointed Superintendent of the Ohio River R. R., with office at Parkersburg, W. Va.

Mr. R. O. Pease, of Chicago, has been appointed Superintendent of Bridges and Buildings of the Louisiana Division of the Illinois Central R. R.

Mr. George H. Coryell has resigned his position with the West Virginia Central & Pittsburg Ry., and will engage in practice as a civil engineer. He has opened an office at Washington, D. C.

Col. R. J. Hinton, Special Agent of the recently completed Irrigation Inquiry carried on by the U. S. Department of Agriculture, will take an editorial position with the "Irrigation Age," of Salt Lake City, on May 1.

The firm of A. A. Campbell & Co., of Chicago, has been organized to carry on a general contracting business, by A. A. Campbell, W. P. Rounds and C. N. G. Davies. The company's office is in the Rookery Building. The company will be glad to receive catalogues, price lists, etc.

Mr. Alexander Mitchell, Superintendent of the Wyoming Division of the Lehigh Valley R. R., has been appointed Superintendent of Motive Power and Rolling Stock of the Northern and Eastern Divisions of the Philadelphia & Reading R. R.

Gen. Charles W. Field died at Washington, D. C., April 9. He was born at Lexington, Ky., in 1828, and graduated from West Point in 1849. He served in the Confederate Army during the war. In 1875 he entered the Army of the Khedive of Egypt, as a colonel of engineers. On his return to Washington in 1877, he followed the profession of civil engineer for a few years, and from 1881 to 1884 he served as a civil engineer for the Government.

NEW PUBLICATIONS.

REPORT OF THE STATE RAILROAD COMMISSIONER OF RHODE ISLAND, for the Year ending June 30, 1891; Pub. Doc., pp. 188.

The great advance made in the steam heating of passenger cars is the principal point of interest in this report. Of the 987 passenger cars owned by the several roads carrying on business in the state, 595 were heated by direct steam, 293 by heaters of various kinds, and 57 by common stoves, on June 30, 1891. The Commissioner also states that, on Dec. 31, 1891, no cars in use in the state were heated by stoves. This rapid disuse of stoves is largely the result of the law passed in 1890, forbidding their use after Dec. 1, 1891. The report says:

"The question of the advisability of heating passenger cars by steam is no longer an open one. The results where it has been fully tested, are highly satisfactory. Not a single accident to passengers has occurred from its use, while the cars have been kept at a much more uniform temperature, greatly to the comfort of their occupants."

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF IOWA, for the Year ending June 30, 1891. Pub. Doc., 8vo., pp. 881.

The report shows that there are 8,413 miles of railway line in the state, placing it fifth in mileage of the states of the United States, and says: "Iowa is at present so covered with railways that no spot can be found within our borders that is 15 miles from a railway." We would commend the last statement to the consideration of some of our contemporaries, with the remark that it states a condition far more responsible for the lack of extensive railway construction in Iowa, than the "severe laws" which they are denouncing. The statistics given in the report show that notwithstanding the reduced rates introduced by the Commission in 1889, there has been a constant increase in the revenue and tonnage of the railways operating in the state.

A gratifying increase is also shown in the use of automatic brakes and couplers, as will be seen from the accompanying table, re-arranged from the report:

	Total equipment.	Number with brakes.	Number equipped with couplers.
Locomotives	3,910	2,872	..
Passenger cars	2,805	2,805	2,727
Freight cars	116,356	11,821	14,904
Cars in company's service	3,241	64	186
Cars leased	3,782	70	250
Total	130,094	17,632	18,137
Total, 1890	125,595	12,861	9,194
Inc. per cent., 1891	3.58	37.0	97.2

The larger part of the remainder of the report is taken up with the discussion of rate questions, and the tables of returns from the different companies.

PUBLIC WORKS DEPARTMENT, SOUTH AUSTRALIA.—Report for the Year ending June 30, 1891. Wm. B. Rounsevell, Commissioner; Alex. B. Moncrieff, Engineer-in-Chief; Adelaide, South Australia; 4 to., pp. 76; tables and folding plates.

This report contains some interesting and valuable matter regarding domestic and irrigation water supplies, stream gagings, river improvements, artesian wells and other public works in South Australia. An outline is given of a proposed new water supply for Adelaide. Diagrams show sections of artesian wells and gagings at several stations on the Murray River. A map on a scale of 35 miles to the inch shows by colored symbols the location and extent of various public works in charge of the Public Works Department and some plans and elevations of public buildings are given.

VICTORIAN WATER SUPPLY.—Report by the Minister of Water Supply, Geo. Graham, Minister; Stewart Murray, Chief Engineer; Maximilian Hector, C. E., member of the Department. Melbourne, Victoria, 4 to., pp. 49; tables and folding plates.

This report contains much valuable information regarding irrigation and municipal water-works, both descriptive and statistical matter being given. Results are presented of analyses of 60 samples of water 12 samples to determine the fitness of the water for domestic use and 48 to determine the fertilizing value and general suitability of the water for irrigation. In connection with the samples designed for irrigation the quantity and money value of the materials found in the water are stated, the money value being given for all material as sediment and all material in solution. Two values of the material in solution are given, one for use with 1-in. and the other 20-ins. of water.

Views of several weirs are given, and there is a map of Victoria on a scale of 16 miles to the inch, showing the different works and areas under the charge of the department.

HONEY LAKE LAND & WATER CO.—Report to the company on its irrigation system in Honey Lake Valley, Lassen Co., Cal. By L. H. Taylor, Engineer-in-Chief and C. E. Grunsky and William Minto, Consulting Engineers, San Francisco. 8vo. pamph.; pp. 16; 4 folding plates.

This company's scheme includes an earth dam 95 ft. high and 950 ft. long; also 24 miles of main canals, 28 miles of secondary canals and 57 miles of small laterals. The report contains maps and a section through the proposed dam. We are informed that the system was put under construction some time ago.

IRRIGATION FOR HOMESTEADERS IN WESTERN KANSAS. By Col. W Tweeddale, C. E. 8vo., pamph., pp. 6.

This pamphlet consists of a paper read before the Kansas State Board of Agriculture. The author thinks that where conditions are favorable the owner of each quarter section of land can store water enough to irrigate 40 acres. Pumping from shallow wells can sometimes be used to advantage. The use of pipe instead of open ditches for distributing systems is recommended.

BRICK FOR STREET PAVEMENTS.—An account of Tests Made of Brick and Paving Blocks, with a brief discussion of Street Pavements and the Method of Constructing them. By M. D. Burke, C. E. Robert Clarke & Co., Cincinnati, O., 8vo., pp. 86, $1.00.

This pamphlet contains the results of a series of tests made by the author, while village engineer of Avondale. They include tests of 15 varieties of paving brick and blocks from as many manufacturers. The method of testing is described and the result given in tabular form, for abrasion and impact, absorption and transverse strength. The author discusses the chemistry of brick manufacture, and gives statistics of traffic on the durability of pavements. Concise and useful hints are given as to the specifications for brick pavements, when they should be used, method of laying and their maintenance. It is

a useful and timely work, with the subject well presented.

TRADE PUBLICATIONS.

HISTORY OF THE PORTLAND CEMENT INDUSTRY IN THE UNITED STATES. American Cement Co., Philadelphia, Pa. 4to. pp. 76; illustrated.

This is much more than a trade publication, though issued by the manufacturers of an American cement of exceptional quality. It commences with a concise but most interesting history of the discovery, invention, use and manufacture of hydraulic cement, in Europe and America, an abstract of which is elsewhere given. The second part is devoted to the scientific tests of cement by engineers, including the various standards of excellence, or specifications fixed by various engineers and engineering bodies. Then come comparative tests of the American Portland cement with various brands manufactured in foreign countries, as made by various users of authority, including the United States Government. The chemical analysis of various brands of cements follows. The pamplet is illustrated by handsome phototype views of structures aggregating $100,000,000 in value in which American Portland cement has been used. Testimonials from users, and a few pages of clear and concise notes on cement and its use, as compiled from the best authorities, concludes this elegantly printed and useful pamphlet.

TRIPLE-LAP SHEET PILING. Wakefield Sheet Piling Co., Chicago, Ill., 12mo.; pp. 22; cuts.

This pile was described in our issue of March 1, 1890. It consists essentially of three planks of equal width put together in such manner as to form a tongue-and groove. It has been in successful use since 1889 in cofferdam construction, and the Illinois Steel Co. employed it in building a dock 2,000 ft. long, and a compound pile of this character, made of 2 by 12 in. Norway pine was driven 24 ft. deep into lake sand and clay. It is claimed by those using them that they stand more pounding than the average solid pile.

METALLIC THERMOMETERS.—Standard Thermometer Co., Peabody, Mass.—Oblong; catalogue No. 26, for mechanical uses, pp. 25; No. 27, for general use, pp. 23; illustrated.

As indicated above these catalogues describe metallic thermometers for both mechanical and general uses. The thermometers all have dial indicators.

THE TELEMETER SYSTEM.—Standard Thermometer Co., Peabody, Mass.—Oblong, 12mo., pp. 46.

Illustrated descriptions of apparatus designed to electrically transmit and record the indications of thermometers, barometers, pressure gages, electrical measuring instruments, revolutions of shafts or dial indications; also heights of gas or water, including the rise or fall of tides.

SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF PHILADELPHIA.—Regular meeting April 2, 1892, President James Christie in the chair; 38 members present. Mr. W. S. Auchincloss read a paper on "Yearly Tides." In this paper the author stated that he proposed to show that confined bodies of fresh water are subject to yearly tides of greater or less magnitude, depending upon the nature of the basin or upon the strata to which they are confined, and upon the effect of evaporation if in an open basin. In March, 1885, he had occasion to sink a well near Bryn Mawr, Pa., and he observed the depth of the water at intervals 10 days apart. It soon became evident that the water was receding. In 1886 there was a rise of the surface and a total gain of 12 ft. His curiosity was aroused and he determined to study the law, if such a law existed, of this ebb and flow. These observations have been continued during the past seven years. He found that in normal years the surface of the water reached its lowest level in December, rises until June, and descends during the autumn. An examination of the amount of the rainfall shows that while the amount of rainfall was as great or greater during the last half of the year as during the first, the level of the water in the well continually lowered. Atmospheric temperature had practically no effect, as the temperature of the water in the well is practically constant all the year round. The depth of the well prevented evaporation from its surface from having any effect. The author believes that the true cause is the result of the influences of gravity and of the sun's attraction at different seasons of the year. When the sun reaches its furthest point south of the equator, gravity exerts its maximum influence on the waters of the northern hemisphere. The waters of the earth will be drawn into the minutest crevices and the surfaces lowered, but in June they will, in a measure, be released, and, under the influence of adhesion and friction, will be held at a higher level than during any other season of the year. Data obtained from the Government records, showing the depth of water in the Great Lakes, show that there is a similar rise and fall, the range of yearly ebb and flow being from 12 to 15 in. in our northern lakes.

Mr. John E. Codman—For the years 1883, 1884 and 1885, the rainfall was a little below the average in eastern Pennsylvania. In 1886 and 1887 it was about the average. In 1888 it occurred late, and in 1889 was abnormal, being somewhat over 60 ins. The diagram shows that the depth of water in the well during this abnormal year was held at very much above the normal level. The quantity of water discharged by the streams was very much in excess of the quantity to be expected from the amount of rainfall. In 1890 the rainfall was above the average again, as shown on the diagram, but was uniformly distributed through the year.

Mr. Jacques W. Redway presented a paper on "The Influence of Rainfall on Commercial Development—A Study of the Arid Region." Mr. Redway, after defining the conditions which go to make up desert lands, took up principally the condition of affairs in the United States, showing that in no part of the United States east of the Mississippi River are the conditions such as will bring any portion under his definition, as the rainfall is always over 30 ins. a year, the average being nearer 40 ins. Beyond the Missouri the rainfall lessens considerably, and, except on the northern part of the Pacific Slope, no portion of this area receives more than 30 ins. of rain, the average being less than 15 ins. The arid lands of the United States cover upward of 900,000,000 acres; in other words, one-third of the territory of the United States consists of land that cannot yield food crops without artificial aid. The author then takes up the methods of irrigation, showing that the only feasible method is that of storage basins, which must, of necessity, because of the interest involved, be under the control of the National Government.

H. W. Spangler, Secretary pro tem.

SOUTHERN AND SOUTHWESTERN RAILROAD CLUB.—The next meeting will take place at the Kimball House, Atlanta, Ga., April 21. The subjects for discussion will be as follows: "Rule No. 8, M. C. B. Code of Rules;" "Joint Inspection;" "Charges for Wrong Material in Freight Car Repairs;" "Locomotive Cylinders; the effect of wear from packing, best style of packing ring where economy of first cost is considered." The experience of those using 18-in. cylinders or over is especially desired. The following committees are expected to make reports: Repair work on large systems and location of plants for same; the best sizes and shapes and modes of fastening draft timbers, and best type of draft rigging; the best practice of setting flues, and proper treatment of same to prevent leaking; the most suitable form of performance sheet for general use.

S. A. Charpiot, Secy.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.—At the regular monthly meeting, on April 4, President Woodman in the chair, Mr. R. Davenport read a paper on "The Red River of the North." This river is a ditch in the prairie, meandering on an average two miles to make one, with a discharge varying from 250 to 20,000 cu. ft. per sec. at Breckenridge, and from 600 to 50,000 at Pembina. In 1877 was begun the first work of improvement, estimated to cost about $500,000, and intended to render the river navigable during a part of the year for flat bottomed craft, by dredging and the removal of bank obstacles from Breckenridge to the Canada line, a distance of about 200 miles, and $240,000 have already been expended. The banks are subject to slides peculiar to the river; large masses of earth having a tendency to work themselves into the river at the level of its bed in the form of wedges extending horizontally well back from the river. The movement of these masses leaves the surface of the bank above to settle undisturbed. The traffic on the river, wholly local, seems to have varied with the precipitation. From 1879 to 1882 it increased from 18,000 tons to 32,000 tons, then decreased to 1,700 tons in 1890. Last season it grew to 12,000 tons.

It is estimated by Maj. Jones, U. S. Engineer Corps, that a further expenditure of $300,000 for reservoirs would make the river navigable throughout the year, excepting in the frozen season. With $550,000 more in the locks, dams and cuts, the length of navigable tributaries might be doubled.

C. L. Annan, Secy.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The next meeting will be held in the Lake Champlain region, commencing at Plattsburgh, N. Y., June 21. Arrangements are in progress for visits to mines and furnaces, and a trip into the Adirondacks. Contributions to the discussion of magnetic iron ore concentration, also of crushers, granulators and pulverizers, are specially invited. The paper of Mr. Hoffman, read at the Baltimore meeting and describing the Sturtevant mill, furnishes a starting point for debate, whether by criticism or by the description of other apparatus.

An International Engineering Headquarters will be maintained in Chicago during the World's Columbian Exposition of 1893. The estimated expense will be $15,000, which must be met by contributions from American engineers. The committee in charge comprises two representatives of the Institute, and many of the members. The Council has also undertaken, at the request of the General Committee of Engineering Societies, to organize and conduct the Mining and Metallurgical Departments of the World's Engineering Congress of 1893 in Chicago. The Council, therefore, now appeals to members and associates for liberal subscriptions to a special Columbian Exposition fund.

R. W. Raymond, Secy.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on April 6, President Johnson in the chair, and 23 members and two visitors present, Prof. Potter reported that at a meeting of the citizens' committee for the abatement of the smoke nuisance an executive committee had been appointed, and had elected the following officers: President, D. L. Kingsland; Vice-President, C. H. Sampson; Treasurer, S. M. Kennard; Secretary, C. H. Huttig.

Mr. E. A. Hermann read a paper of the evening, on "Steam Shovels and Steam Shovel Work." He said that the steam shovel is not a very old machine; its general use dates from about 1875. The steam shovels for railway use only differ from those for general work in being mounted on standard gage trucks. The machinery works either through positive gearing or through friction clutches. The latter works more rapidly and is better adapted for softer materials, but heats the clutches easily, often causing delays. The positive gearing machines are a little slower but more reliable, especially for hard material. The capacity of dipper varies from ½ to 2 cu. yds.

Mr. Perkins described an instance of the delivery pipe from a boiler becoming choked with scale. Col. Meier cited an instance where the intrainment was 14 per cent. Prof. Johnson exhibited the first scientific book on the truss bridge, entitled "Bridge Building," by S. Whipple, published in 1847.

For the meeting on April 20, a paper by Mr. B. F. Crow on "Elements Involved in Rapid Transit" was announced.

Arthur Thacher, Sec.

COMING TECHNICAL MEETINGS.

WESTERN RAILWAY CLUB.
April 19. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 19. Secy., E. N. Clark, Pittsburg, Pa.
"Hydraulics of Large Rivers." Geo. S. Davison.
BOSTON SOCIETY OF CIVIL ENGINEERS.
April 20. Secy., S. E. Tinkham, City Hall.
ENGINEERS' CLUB OF ST. LOUIS.
April 20. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 20. Secy., F. Collingwood, 127 East 23d St., New York.
Discussion on tests of iron and steel.
June 8. Annual Convention, Old Point Comfort, Va.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 21. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF CINCINNATI.
April 21. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO
April 21. Secy., T. G. Pihlfeldt, 113 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 21. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
April 21. At 12 W. 31st St. Secy., H. G. Prout, 73 Broadway.
DENVER SOCIETY OF CIVIL ENGINEERS.
April 26. Secy., Geo. H. Angell, Jacobson Block.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
May 2. Secy., C. L. Annan.
WESTERN SOCIETY OF ENGINEERS.
May 4. Secy., J. W. Weston, 230 La Salle St., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
May 5. Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
May 6. Secy., E. K. Smoot, 903 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
May 6. Secy., O. von Geldern, 819 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
May 7. Secy., P. Valentine. At 281 Union St., Brooklyn, and 616 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
May 7. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
May 7. 1122 Girard St. Secy., J. C. Trautwine.
ENGINEERS' CLUB OF KANSAS CITY.
May 9. Baird Building. Secy., H. Goldmark.
WISCONSIN POLYTECHNIC SOCIETY.
May 9. Loan & Trust Bldg., Milwaukee. Secy., M. Shinke.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
May 10. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
May 10. Secy., A. H. Porter, 50 Euclid Ave.
NORTHWESTERN SOCIETY OF ENGINEERS.
May 10. Occidental Block, Seattle. Secy., E. H. Warner.
NEW ENGLAND RAILROAD CLUB.
May 11. United States Hotel, Boston. Secy., F. M. Curtis.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
May 12. Secy., O. H. Landreth, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
May 12. Secy., Edward Mead, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
May 13. Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
May 14. 194 Third Ave. Sec., H. Schreiter.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
May 14. At Roanoke. Secy., J. B. Schick, Roanoke, Va.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 16 to 20. San Francisco, Cal. Secy., F. R. Hutton, 12 W. 31st St., New York.
AMERICAN WATER-WORKS ASSOCIATION.
May 16. Secy., J. H. Decker, East Orange, N. J.
MONTANA SOCIETY OF CIVIL ENGINEERS.
May 21. Secy., F. D. Jones, Helena.
CENTRAL RAILWAY CLUB OF BUFFALO.
May 25. Secy., Jas. Macbeth.
NEW ENGLAND WATER-WORKS ASSOCIATION.
June 8, 9, 10. Holyoke, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
AMERICAN RAILWAY MASTER MECHANICS' ASSOC'N.
June 20. Saratoga N. Y. Secy., A. Sinclair, New York.
AMERICAN INSTITUTE OF MINING ENGINEERS.
June 21. Plattsburg. Secy., R. W. Raymond, New York.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York. Entered at the Post Office, New York City, as Second Class Matter.

VOL. XXVII. SATURDAY, APRIL 16, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: one year, $5.00; 6 months $2.50; 4 months, $2.00; single copies, 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses. No club rates allowed.

The date when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance. No other receipt is sent unless requested.

ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The first duty test of a pumping engine, made according to the standard code of the American Society of Mechanical Engineers, is described elsewhere. As we have before said, the change in the basis for the duty from 100 lbs. of coal to 1,000,000 heat units in dry steam delivered to the engine, is an excellent one. The comparison of the results of different tests is much easier; and the purchaser of pumping engines can with better reason require a duty test, since the standard of measurement is no longer a variable one. The only objection to the use of this unit is that it introduces a term with which the general public is not familiar. But any man who can comprehend the significance of the foot pound as a measure of work can understand that 1,000,000 heat units is about the available heat in 100 lbs. of good coal.

A matter of great interest to water-works officials is the contrast between the duty developed by the new high-duty engine and that shown by the two old engines in the Lowell pumping station, built less than a score of years ago. The high-duty engine will develop 400 HP. in 12 hours work daily for a year with an expenditure of 1,576 tons of coal, according to its duty test, or 1.8 lbs. of coal per HP. hour. The two old engines, to do a similar amount of work, would require, respectively, 2,233 tons and 3,241 tons. If the above figures fairly represent the duties of these engines in regular service, it would apparently be economical for the city to consign the lowest duty engine to the scrap heap. Yet as a matter of fact the above duties are probably considerably higher than the average obtained from the engines of antiquated type which are doing service in many pumping stations. A few years ago the purchase and building of a high-duty pumping engine was something of an experiment. At the present time the attainment of high duties in regular service is a common thing, and contractors are ready to guarantee the duty of their engines whenever the purchaser requires it. This being the case it is certainly a penny wise and pound foolish policy to keep in service old engines using four or five pounds of coal or more per horse power. If room can be spared, such old machines may well be kept for emergency use; but the regular work should be done by engines able to use fuel with greater economy.

A most interesting test of the toughness of nicked steel under impact is reported in another column. and should be noticed by every one interested in the current discussion on soft steel vs. wrought iron. The test was made to determine whether cutting a screw thread on soft steel seriously affects the ability of the metal to resist either steady strain or sudden impact. The test was made by putting a full size eye-bar, with a section upset and joined by a turnbuckle, into a hydraulic testing machine and straining it up to its breaking point. When the bar was under a tension of over 8,000 lbs. per square inch greater than its elastic limit, a weight of over 1,000 lbs. was dropped on the bar from a height of 2 ft. The tension and height of drop were increased until the bar broke at the eighth blow at a strain 25,000 lbs. per square inch beyond the elastic limit, with a drop of the weight of 6 ft. It should be said that the cross section of the bar at the bottom of the screw threads was only 14 per cent. in excess of its normal section. If any maker of wrought iron can show material which will stand equally well a test of such severity, those who still prefer to rely on that material for structural work would doubtless be glad to hear from him.

A somewhat unseemly controversy, and yet one for which neither side can be blamed, has been going on for some time between the son of Alfred Vail and the daughter of Prof. S. F. B. Morse. As we explained in detail in our issue of April 14, 1888, Mr. Vail was beyond all doubt the original and sole inventor of both the principle and the details of the so-called "Morse" dot-and-dash alphabet, and the so-called "Morse" receiving recorder. Mr. Vail himself put this on record in the following words bearing upon the first recorder ever made, which it is proposed shall be purchased by Congress:

> This lever and roller were invented by me in the sixth story of "The New York Observer" office in 1844, before we put up the telegraph line between Washington and Baltimore, and the same has always been used in Morse's instrument. I am the sole and only inventor of this mode of telegraph embossed writing. Professor Morse gave me no clew to it, nor did any one else, and I have not asserted publicly my right as first and sole inventor, because I wished to preserve the peaceful unity of the invention, and because I could not, according to my contract with Professor Morse, have gotten a patent for it.

It has been since shown that Vail was entirely wrong in thinking that he could not take out a patent for his own sole invention merely because he was under contract as an assistant to Prof. Morse, and it is also very generally felt that Morse's treatment of Vail throughout life was not particularly generous, nor even just. An article by Mr. F. L. Pope in the "Century Magazine" for April, 1888, shows the grounds for this belief in still more detail than we did, and even advances the broad claim that "the essential telegraph of to-day and the universal telegraph of the future, comprises solely the work of Joseph Henry and Alfred Vail. The elements contributed by Morse have gradually fallen into desuetude." Nevertheless, there can be no doubt that to Morse's conception and enthusiastic interest we owe the invention of the telegraph when it was invented, and hence we fully believe that he, more than any other one man, deserves to be styled "the" inventor of the telegraph; but it is a hardship that the alphabet at least should not be known as the "Vail" instead of "Morse" alphabet, and it is also a hardship that Vail's share in this grand invention should not be remembered more generally than it is.

WATER SOFTENING PLANTS AND PROCESSES.

We give elsewhere in this issue an illustrated description of what is, so far as we can learn, the largest plant ever established for softening water. On a small scale the softening of water has been often practiced in England, and some attempts have been made to soften the water supply of small towns; but the treatment of the whole supply of a city of 63,000 inhabitants, amounting to over 2,000,000 gallons daily, is, we believe, quite an unprecedented work.

There are two classes of people in the community who are thoroughly appreciative of the ills due to hard water. They are the boilermakers and the washerwomen. We need not explain at length the evils of scale-forming water in steam making, as they are familiar to all engineers. But the effect of hard water in increasing soap consumption is not so familiar, we believe, even to hydraulic engineers. Of course every man is familiar with the fact that it takes more soap to wash one's hands in hard water than in soft; but the actual effect of the hardness of the water upon the value of a water supply for household purposes is not always appreciated. While no exact rule can be given for estimating the increased expense to a community caused by the use of hard water, in general it may be said (Eng. News, Jan. 31, 1885) that each grain of carbonate of lime per gallon of water causes an increased expenditure of 2 oz. of soap per 100 gallons of water. The Southampton water contains about 18 grains of lime and magnesian salts per gallon. With such hard water it is probable that the increased expense for soap in a household of five persons would amount to at least $5 to $10 yearly: hence the inhabitants could afford to pay a higher water rate by the amount of this difference for a soft water supply.

In settling upon the source from which the water supply of a town is to be taken, it not infrequently happens that a choice is presented between a supply from wells and one from a lake or river. In many cases there are strong reasons, such as freedom from contamination, abundance of supply, etc., which will determine the selection of one or the other, since the hardness of the water is certainly a minor consideration. But where other things are equal and the choice is presented between a hard water supply and soft water, the latter is not only preferable, but is worth a considerably increased expenditure to secure.

It is perhaps too much to expect that for many years to come anything will be done toward the introduction of water softening apparatus in public water supplies in this country. While city after city in the West is content with a supply of muddy river water, and many cities, both East and West, have their water supplies dangerously polluted with sewage matter, it is not to be expected that invisible impurities in our water supplies, which are not dangerous to health, will receive much attention.

Nevertheless, it is well for engineers to know what can be and has been done in removing the hardness from water, for there are probably many cities, especially in the West and South, which could profitably undertake the establishment of a water softening plant if public opinion were once informed as to its value. Perhaps some of the filter companies might take this matter up with profit both to themselves and the public; for it is to be noticed that in softening water the precipitation of the lime salts has to be followed by their separation, either by the process of settlement or filtration, the latter being generally preferred.

It is quite likely, however, that the pioneer plants in this country will be established to soften water for use in locomotive boilers. In England, the London & Northwestern Ry. has a plant at Liverpool which removes the hardness from over 200,000 gallons of water daily, and it has also a plant at Camden Town, London. The Taff Vale Ry. has a plant at Penarth Dock, near Cardiff, treating 50,000 gallons daily, and removing both the carbonates and sulphates of lime and magnesium. The cost per 1,000 gallons softened is stated as about 1.26 cts. for the lime, soda and alum used in the work. This plant was described in Proc. Inst. C. E., Vol. XCVII., p. 354.

Thus far in this country the attempts to cope with the evils due to bad water in boilers have been rather ineffectual. Most of those who had done anything have contented themselves with dosing their boilers with some of the many recommended "purges," which range in variety from potatoes to kerosene. The common sense way of keeping scale out of a boiler would seem to be not to put it in. Of course absolutely pure water is not to be had, and softening of water on the small scale necessary for local water stations would seldom be practicable. There are many important railway centers, however, where a large number of locomotives take their supply, and where the water used is not at all conducive to the welfare of the boiler. Water softening plants at some of these places ought to be a profitable investment.

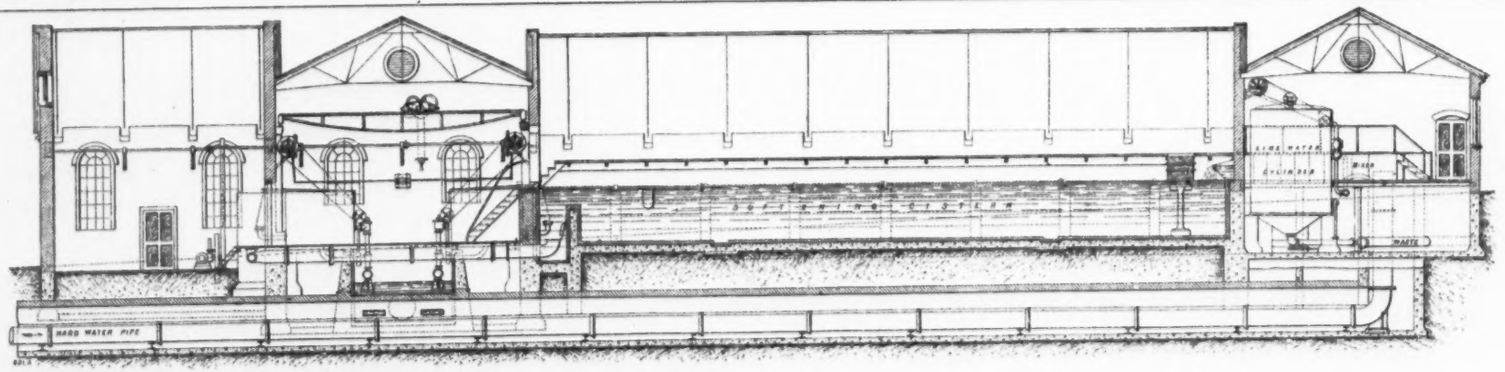


FIG. 1. LONGITUDINAL SECTION.

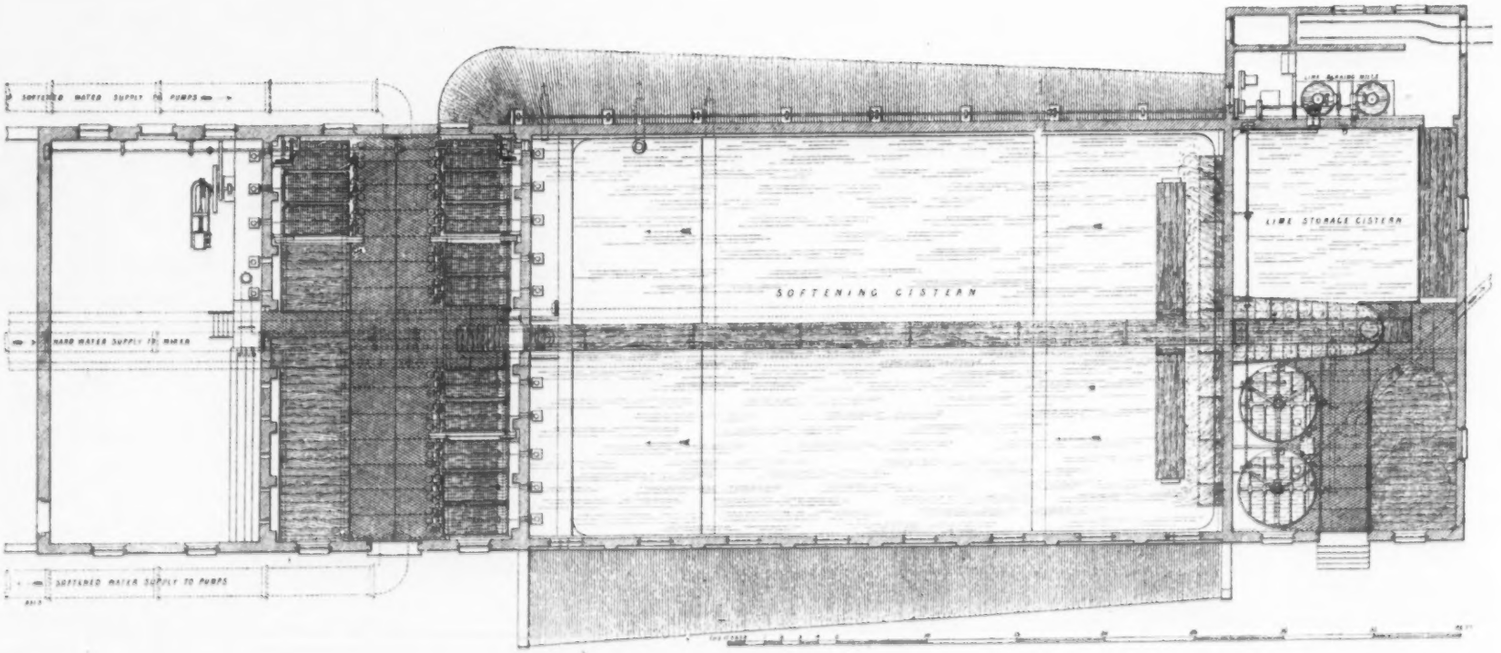

SOFTENED WATER SUPPLY TO PUMPS
HARD WATER SUPPLY TO MIXER
SOFTENED WATER SUPPLY TO PUMPS
SOFTENING CISTERN
LIME STORAGE CISTERN

FIG. 2. GENERAL PLAN OF PLANT.

FIG. 2. GENERAL PLAN OF PLANT.

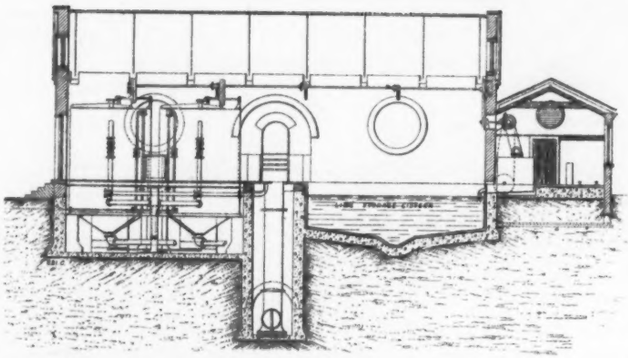


FIG. 3. TRANSVERSE SECTION OF LIME HOUSE.

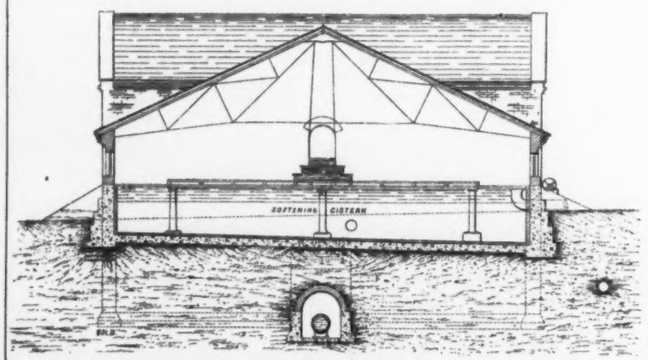


FIG. 4. TRANSVERSE SECTION OF SOFTENING CISTERN.

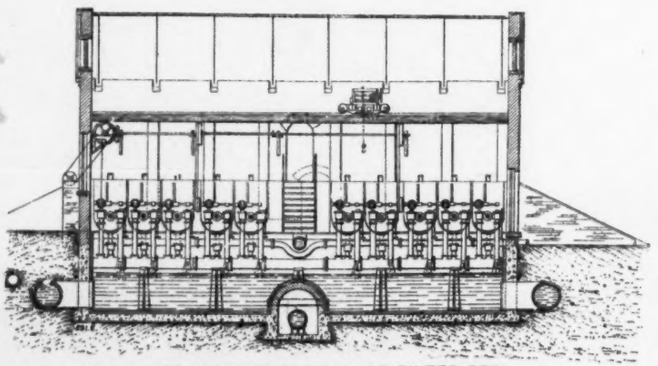


FIG. 5. TRANSVERSE SECTION OF FILTER BED.

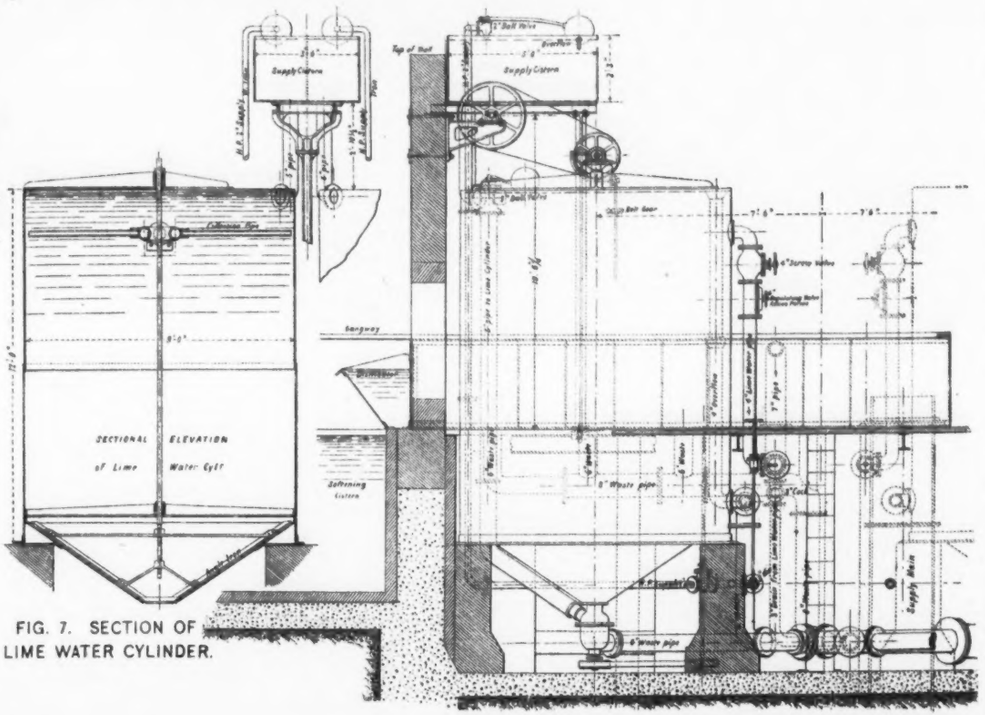


FIG. 7. SECTION OF LIME WATER CYLINDER.

FIG. 6. LIME WATER CYLINDER WITH CONNECTIONS.

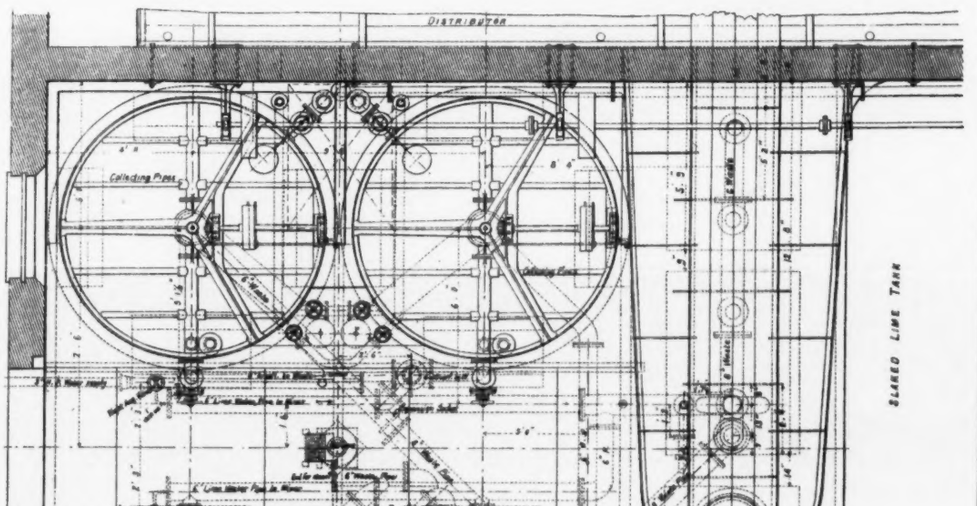


FIG. 5. TRANSVERSE SECTION OF FILTER BED.

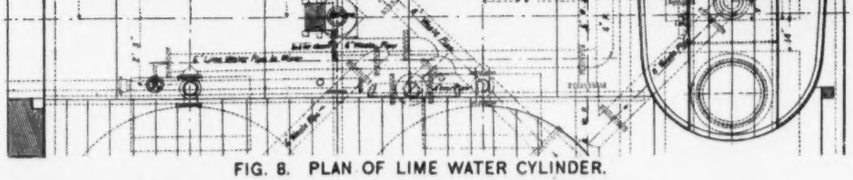


FIG. 8. PLAN OF LIME WATER CYLINDER.

WATER SOFTENING PLANT AT THE SOUTHAMPTON, ENGLAND, WATER-WORKS.

William Matthews, Chief Engineer.

CHAS. HART & SONS, LITH., 39 VESEY ST., N. Y.

THE COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR-LIGHTING.

The series of articles under the above head, which has been appearing at intervals in these columns for nearly a year past, and is concluded with the present issue, had its origin in the following editorial note which was published in our issue of May 11, 1889, or nearly three years ago:

The Pennsylvania R. R. is now experimenting with a system of car lighting by gasoline, which, if the official directions for using it do not exaggerate the precautions necessary, it would seem might just as well be let alone. As the closing article of the instructions state, "gasoline is a very volatile and very inflammable substance." It is, roughly speaking, the most volatile and inflammable eleventh part of the naphtha products of crude petroleum, which naphtha products aggregate about one-sixth of the crude oil, of which, consequently, gasoline is 1½ per cent. Naphtha proper has three recognized grades, which boil at 180, 220 and 300 degrees F., respectively. Gasoline of 85 degrees Beaume boils at 120 degrees F. Gasoline at 88 degrees Beaume, the grade specified, boils at a still lower temperature, verging toward that of rhigoline, the highest and (almost if not quite) the most volatile of natural fluids, which boils at 65 degrees F., and brings down the mercury to—19 degrees F., in 20 seconds. The line between these various petroleum products is not sharp, but good illuminating oil is not permitted to have a higher boiling point than 350 degrees F.

Gasoline is extensively used, with great precautions, for the manufacture of illuminating gas on a small scale for isolated buildings, and with wonderful safety, considering its highly inflammable and volatile nature. Nevertheless, distressing accidents from its use do frequently occur. A tremendous naphtha explosion in Chicago, so recently as April 26, caused a great deal of damage. Recently also, a man's life was lost, and a fine house destroyed, by his clothes becoming insensibly charged with the vapor, which ignited on approaching a furnace in the cellar. On trains it is evident that as great precautions as are possible with stationary gas machines are out of the question, while the demonstrated efficiency of kerosene, gas, and electricity for lighting cars makes it difficult to see why such a substance as gasoline should be tampered with for this use.

The gasoline system above referred to, we may reasonably believe, is as perfect as such a system can be made, and under all ordinary conditions, with regulations lived up to, is perfectly safe. Most dangerous things are. Nevertheless, these are among the instructions given, and all of them made emphatic by being printed in larger type and capitals, instead of in the smaller type which we use:

Under no circumstances should a carbureter lamp be lighted from the top of the lamp or top of the chimney, as is customary with coal gas. An attempt to do this will almost certainly result in an explosion, which will probably break the lamp and may cause serious injury to the operator as well as to the passengers and the car.

In putting out the lamp it is essential to always close the needle valve on the lamp. This differs from the ordinary practice with coal gas, but with the carbureter lamps it is absolutely essential.

It is quite essential that the lamps should all be burned alike. If less light is desired, turn down all the lights; if more is wanted, turn all up.

Never under any circumstances attempt to recharge carbureters with gasoline during the night, nor when any lights are near, nor when passengers are in the car, nor when the car is in a passenger station.

The barrels of gasoline should be stored in the coolest place obtainable; if possible, in a cellar, which should never be entered during the night, nor with a lamp of any kind.

These directions are amplified in smaller type with great minuteness. The absolute impossibility of insuring their enforcement, were such a plan of lighting used on a large scale in the hands of the ordinary reckless employee, and the disastrous consequences which may result from not enforcing them, seem evident. While reluctant to throw cold water on any new enterprise which promises economy (and surely such a system promises nothing but economy as compared with electricity or gas, or even common oil) it is hard to see what advantage can be gained from monkeying with a buzz-saw which requires such elaborate precautions, as compared with what may possibly be lost. If there is another side to this question, we shall be glad to hear and present it; but if we err, the official instructions for the use of this device must also err.

It will be seen that the conditional condemnation above expressed did not purport to be based upon the details of the plant itself, but solely on the official instructions for its use. It was soon represented to us, however, that in thus impliedly condemning a plant, which we did not pretend to have examined at all, we were unfairly prejudging it; that the instructions for its use had been thus drawn only from abundant caution, in order to make employees cautious, and that it was really a safer as well as a better lighting plant than any other in use. We were invited to investigate its comparative merits for ourselves, and every reasonable facility to that end was offered.

We recognized a certain force in this position, and a certain moral claim upon us to form a judgment at first hands or not at all. We sought and obtained the aid of an expert chemist and experimenter, Mr. W. B. D. Penniman, for the experimental work, and undertook to go to the bottom of the whole question of car lighting, so far as our ability permitted. The result has been given in full in these columns, and from the facts presented every interested reader can and should make up his own opinion for himself. He has before him every important fact on which our own conclusions here are based. These last may be grievously in error—time will show—but at the end of such a long investigation it seems becoming that we should state them, either to confirm or retract our opinions formerly expressed.

The carbureter plant, as we now see it, is in some respects safer and in some respects less safe than we expected to find it. In respect to the more obvious sources of danger, which we had chiefly in mind at first, such as explosions of carbureters in service, tearing apart of carbureters in accidents, escapes of gas or liquid through leaks, and the like, it is safer than we had supposed it possible to make it. It is a triumph of mechanical ingenuity and of careful construction. The case in favor of its sufficient safety proved to be much stronger than we had expected to find it, so strong that we were at one time almost prepared to accept it, having no stronger reason to advance for not doing so than a vague suspicion that there must be a screw loose somewhere; so strong that we have ceased to wonder that cautious and able mechanical officers should accept it as conclusive, as many of them have done. We do not consider, moreover, that any one of the four modes of car-lighting now prominent is ever likely to be a frequent source of accident, so that, if the choice lay between using any one of them and a return to candles for car-lighting, for example, we should oppose the use of candles.

But having said this we have said all that seems to make in favor of the use of gasoline for car lighting. Our investigations have revealed to us sources of danger not heretofore admitted at least, and we fully believe not expected. We think the facts show that while not absolutely very dangerous, car lighting by gasoline is much more dangerous to life and property than any other prominent system of lighting. This fact alone would not condemn it, for it is an utter fallacy to assume that the safest thing should always be used in railway or any other service. Quality and cost must also be considered, and may easily outweigh a moderate amount of increased danger.

But our investigations have further satisfied us that in both cost and quality of light, as well as in safety, gasoline car-lighting is inferior to others. Our analysis of cost (Eng. News, March 12, 19, 1892), while probably not strictly accurate for any one road, satisfies us that in no case can gasoline carbureters furnish a sensibly cheaper light than either oil lamps or oil gas, while it is likely to be dearer by a varying but considerable percentage, for equal light and with all cost items considered or allowed for.

Finally, as to quality of light, while the carbureter light is at times very good, it is at times very poor, and is greatly affected by extremes of temperature. On a recent trip over the Pennsylvania Railroad, for example, we noted three different styles of lamp in use on five different cars. One car was very brilliantly illuminated by a new style of lamp, which we had never heard of before and which has been very recently introduced. The other four cars were all very dimly lighted (on a moderately cold day, with the air above freezing), two of them by the standard Lundgren lamp, and the other two by an older P. R. R. standard. Yet there were six or more lamps per car in use, and every lamp was turned up as high as possible, so high that in each of the four cars there was one or more lamps (seven in all) smoking and depositing soot both at the beginning and at the end of a two-hour trip.

We believe there is but one practicable remedy for this trouble, and that only a partial one, viz., to turn so much heat around the carbureters as to practically boil the gasoline. This latter, one of the strongest friends of the system admits to us (and we agree with him), makes the carbureters "extremely dangerous things" and "damns the system completely." Numerous other remedies have been tried. The carbureter was first under the car, then put on the roof; recently it has been proposed by a carbureter expert to put it back again under the car. Seven different forms of lamps at least have been tried. There are now in use to our knowledge three different forms of ventilators and three different forms of dampers or no-dampers, each of them materially different from the others in their obstruction to the free exit of heat, and hence in their effect on the functional action of the plant. There may be many more varieties already in use, and doubtless will be in the future, if there are not now; for it is one of the serious features of the problem that any tinker can make some seemingly trifling change, which in his blundering judgment is an "improvement," but which will yet profoundly modify the whole nature of the plant.

But all these efforts to strike just the right balance between heat and cold have failed (if general acceptance be the standard of success), and all of them must in our judgment continue to fail. They are not successive advances toward success. They are merely successive efforts to solve a problem as hopelessly insoluble as perpetual motion, which, however long continued, can only end in failure.

For if it be admitted that it is dangerous to habitually heat the gasoline to the boiling point (and we know of no one who denies this) this permanent relation exists; that, although all forms of the plant may at times give good light, and all forms of the plant may be at times safe, and although there is a certain narrow range of favoring external conditions within which any form of the plant will be both working safely and giving good light; yet speaking in the large, and apart from the lucky exceptions, when the light is good it is not safe, and when the light is safe it is not good. Moreover, while the plant may be and has been so modified as to lean toward one or the other of these alternatives, yet neither horn of the dilemma has been or ever can be wholly eliminated in any form of the plant.

This results from the very nature of the problem, which, in its essence, is this: Given a variable product, used under lawlessly variable modifying conditions in a non-adjusting plant, to produce an invariable result. It cannot be done.

More specifically, we have a product to deal with which must be and is heated to between 80 degrees and 90 degrees F. in order to charge air with sufficient gasoline vapor to give off a good light. If the temperature falls lower the gas becomes poor. On the other hand, we must not heat the gasoline above 92 degrees to 110 degrees F., or part or all of the contained gasoline will be heated above the boiling point and give off steam. To make the light both good and safe, therefore, we have to keep the carbureter temperatures within these narrow limits under external temperatures varying from 150 degrees F. in the sun with still air to — 20 degrees F. with a gale of wind blowing, and using a gasoline which, as purchased in the market, varies from 95 degrees to 110 degrees in its mean boiling point, and which, even if uniform in mean boiling point, is still a composite liquid containing a certain large percentage which boils or distills over under a slow heat at a much lower temperature than the mean boiling point.

Under these conditions we may sheer off from either Scylla or Charybdis, as we please. We may say, whatever else happens, the light shall be good, and so throw so much heat around the carbureter that for a good part of the time the gasoline shall be heated to the boiling point when the lamps are burning; or we may say, whatever else happens we will not boil the gasoline, and so throw so little heat around the carbureters that in cold weather they will give off a very poor gas. But we cannot do both at once, and what is more, we cannot avoid doing first one and then (at times) the other, with any form of the plant to us conceivable, or which closely resembles those now in use. The Pennsylvania plant has been designed to insure safety by avoiding overheating, and as a consequence the light

(according to our observation) is often poor and dim, yet it is an admitted fact that in summer weather gasoline steam often blows off through the safety valve. On the other hand, most of the plants in use on other roads have been designed to insure a good light first of all, by heating the carbureter hotter, and thus, if our tests gave correct indications, very frequently heating the gasoline to the boiling point, yet various records which we have given show that in cold weather they also give too poor gas.

There remains but one alternative under which to claim a favorable verdict for the use of gasoline in car-lighting. It is open to claim that, after all, it is not really dangerous to boil the gasoline, on the ground that it merely fills the pipes with gas under light pressure controlled by a safety valve, which is no more dangerous than any other gas. As no one has ever yet taken this position, publicly at least, we need not discuss it. But one of several answers which might be made to it is that the gasoline vapor does not, like a fixed gas, tend to rise in air and dissipate itself, if it accidentally escapes, but tends to fall through air almost like a fluid and collect in pools or attach itself to clothing or wreckage; besides which, considerable condensed liquid may escape with it.

For these and other reasons we see no escape from the conclusion that gasoline carbureter plant when in use on cars does contain some elements of special danger. When a man has convinced himself to the contrary and has also convinced himself that there are no elements of special danger in having gasoline about his yards and trains outside the carbureters, and that there is no increase in cost of light over oil or oil gas, and that there is no greater tendency to variable light under variable conditions, he then has grounds for looking on the use of gasoline for car-lighting with some favor. Until he has done all these things we do not see how he can feel that he has grounds for doing so.

LETTERS TO THE EDITOR.

LONG CABLEWAYS.

Sir: We note in your issue of March 26 a reference to long span cable-ways. We have designed, erected and have in operation at the Culver Mining Co.'s property in the Peshastin Mining District, Wash., an endless ropeway, 6,140 ft. in length, for transportation of ore from mine to mill. As originally erected and operated it had two spans of extraordinary length, viz.: 2,197 ft. and 1,750 ft. We later on reduced this 2,197 ft. length to 1,783 ft. by putting in another station although there was no physical reason for so doing. Extremely long spans are not economical, and should be avoided where possible. The rope is crucible steel, 5-8 in. diameter, and was loaded on the long spans to 1,800 lbs. The usual speed is 4 miles per hour. This is the first bucket-tramway erected in the state. It works satisfactorily, and in addition to carrying return loads to the mine, it develops 10 to 12 HP. for use at the mill.

Yours truly, Warner & Warner,
Civil and Mining Engineers.

Seattle, Wash., April 2, 1892.

A "NOVEL" LEVEL AND LEVEL ROD.

Sir: The "novel" type of level and level rod illustrated in your issue of April 2, 1892, was described and illustrated in a publication entitled "Nivellement de Precision de la Suisse," printed in 1867. Instructions for the use of these instruments are given in the same and subsequent issues of the same publication. The cuts you show are copied from that publication.

The striding level is shown with its cover removed. This cover carries a mirror, by means of which the position of the level (bubble) may be observed with the eye at the eye-piece of the telescope. Instruments of this class and made by the same maker, have been used by the Corps of Engineers, U. S. A., since 1876, in determining the elevation of the Great Lakes, in levelings along the Mississippi, Missouri and St. Mary's Rivers, and in other places. I prepared instructions for the use of these instruments on the Mississippi River, which were published in the Report of the Chief of Engineers for 1880, p. 2428.

These instruments present great advantages, but must be carefully handled, as must all instruments of precision. The instruments in use on the Mississippi River have attached to the horizontal bar a small watch level, suggested by myself at the time they were ordered, which is a great convenience, as it shows the observer how to place the tripod, so as to bring the instrument nearly into position before using the leveling screws.

The micrometrical elevating screw at the end of the horizontal bar aids greatly in the rapid working of the instrument. These instruments permit more rapid work, greater precision of results and greater convenience to the observer than the ordinary levels, but are too delicate to place in the hands of "greenhorns."

Yours truly, L. L. Wheeler,

Milan, April 8, 1892.

(The recent German publication from which we took the description (with credit) made no allusion to the fact that the device was old, and it was new to us, and also, we thought, good.—Ed.)

A LARGE WATER SOFTENING PLANT.
(With inset.)

The city of Southampton, England, is, so far as we can learn, the only city in the world of any considerable size which has established a water softening plant for the treatment of its public water supply. The treatment of hard water on a small scale for the extraction of its injurious impurities has long been practiced in England, and the various systems used were fully described in a paper by Baldwin Latham in our issues of Jan. 31 and Feb. 7, 1885. The softening of the whole water supply for a large city, however, is quite unprecedented; and since the plant at Southampton seems to be a thorough success, it deserves a careful examination by hydraulic engineers.

The chemistry of the process of softening water is exceedingly simple. The hardness of water is due usually to the presence of calcium carbonate (limestone), which is dissolved by the water in running over calcareous rocks, or through soils containing decomposed limestone. Now calcium carbonate is but slightly soluble in pure water; but water containing carbonic acid gas can dissolve a considerable amount. The carbonic acid combines with the calcium carbonate to form a calcium bicarbonate which is soluble in water. If, now, to water containing this calcium bicarbonate in solution, a quantity of lime water be added, the calcium oxide in the lime water will decompose the bicarbonate and take away its carbonic acid, forming calcium carbonate, the reactions being as follows:

$$Ca\,O + CO_2 = Ca\,CO_3$$
$$Ca\,C_2\,O_6 - CO_2 = Ca\,CO_3$$

The calcium carbonate is formed as an exceedingly fine precipitate throughout the water, so fine that its separation by settlement is a tedious process, and that filtration is exceedingly difficult, the fine grains passing through the interstices of the filter, or else accumulating on its surface in an almost watertight mass. The problem of filtration, therefore, is the one of chief difficulty in the practical application of this process. We reprint from "Engineering" the following description of the Southampton plant and the drawings showing its construction.

Previous to 1887 the Corporation of Southampton supplied water to a population of 63,500 persons within the municipal limits, the average daily amount in the three years preceding and including 1887 being 2,890,000 gallons a day, of which 187,000 were for trade and manufacturing purposes. This was obtained from the river Itchen, and was far from being satisfactory. A new source was, therefore, sought, and was obtained by tapping the chalk at Otterbourne, where a large well was completed, from which an abundant supply has since been obtained. As in all cases in which water is derived from the chalk, the supply was very hard, marking 18 degrees on the Clark scale. It was, therefore, determined to subject it to a softening process immediately it was raised, and thus save the townspeople the expense and annoyance which attend the use of hard water. The lime process, originally patented by Clark, was selected; indeed, there is practically no other. As most people are aware, this process consists in adding lime water (a solution of hydrate of lime) to the water to be treated. The hydrate of lime combines with the carbonic acid in the water, and the carbonate of lime is precipitated in insoluble crystals. Although the process is very simple in itself, it is difficult to carry out, on account of the trouble of separating the carbonate from the water, and many different forms of apparatus have been devised to accomplish this end. The one adopted in this case, which is, we believe, the largest and most successful example of water softening in this country, is that known as the Atkins apparatus. So effectual is it at Southampton that it reduces the hardness from 18 degrees to 6 degrees, for a cost of .225d. (0.45 ct.) per 1,000 gallons. From every gallon of water there is precipitated 12.78 grains of carbonate of lime; from the aggregate of 2,000,000 gallons per day this amounts to 1½ tons of carbonate, to which must be added ½ ton of lime used in the process. If this had to be precipitated by soap in the houses of the users, it would require some 10 tons of soap to accomplish. Of course, it is only the water used in washing clothes that is completely softened in domestic operations.

The works at Southampton were laid out by the water-works engineer, Mr. W. Matthews, to deal with 2,000,000 gallons a day, with easy facility of extension to 3,000,000 gallons. The analysis of the water, before and after softening, is given in the annexed table by Dr. P. F. Frankland:

General Sanitary Analysis.

	Parts in 100,000 (a) Unsoftened.	Softened.
Total solid matter	31.60	14.07
Organic carbon	.024	.021
" nitrogen	.012	.013
Ammonia	.005	.004
Nitrogen, as nitrates and nitrites	.365	.381
Total combined nitrogen	.381	.397
Chlorine	1.6	1.6
Hardness.. Temporary	23.0	5.6
Hardness.. Permanent	2.7	3.0
Hardness.. Total	25.7	8.6

Mineral Analysis.

Silica ($Si\,O_3$)	1.02	.94
Oxide of iron and alumina ($Fe_2\,O_3$ and $Al_2\,O_3$)	.14	.11
Lime ($Ca\,O$)	14.53	4.42
Magnesia ($Mg\,O$)	.25	.28
Soda ($Na_2\,O$)	1.21	1.12
Sulphuric oxide ($S\,O_3$)	.39	.45
Nitric acid ($N_2\,O_5$)	1.41	1.47
Chlorine (Cl)	1.60	1.60
Carbonic acid ($C\,O_2$) calculated from the carbonates of lime and magnesia	10.64	2.64
	31.19	13.03
Less oxygen—equivalent of chlorine	.36	.36
Total solid residue	30.83	12.67
Carbonate of lime ($Ca\,C\,O_3$)	23.93	5.67
Carbonate of magnesia ($Mg\,C\,O_3$)	.21	.29

The softening apparatus is erected next to the pumping engines. The water from the well is delivered into the large main which runs from end to end of Fig. 1, in a subway which passes under the mechanic's shop, the filter house, the softening cistern, and the mixing house. We will first rapidly follow the course of this water through the various apparatus, and then deal, in more detail, with the individual appliances. The hard water main rises vertically at its extremity, and ends within the mixer (Figs. 1 and 2) which is a round-ended tank containing several baffle-plates which oblige the water to follow a devious course. Over the mixer there is a gangway which stretches the length of the softening cistern, and enables the man in charge to follow his duties without going outside of the building. Concurrently with the hard water there is delivered to the mixer about 10% of lime water, and the two are intimately commingled before they enter the weir like trough which extends nearly the entire width of the softening cistern. Over the lip of this trough the water falls in a small cascade to commence its passage through the cistern. This is made of considerable dimensions, because although the precipitation of the carbonate of lime commences very rapidly, it is some considerable time before the process is complete, the operation proceeding sluggishly toward the end.

At the other end of the cistern the water, now full of milky turbidity, enters the filters. There are ten of these having direct inlets from the softening cistern, and three others served by the pipe passing under the floor of the filter house in Fig. 1. There is also space left for the erection of seven more filters should the extension of Southampton demand them. In the filters the carbonate of lime is deposited on the cloths, while the clear and soft water flows into the large main shown in Fig. 2. This is connected to the suctions of the forcing pumps, which deliver the water to an elevated service reservoir, from which it flows by gravity to the town.

Having thus traced the general process, we will turn to the details. The quicklime is obtained by burning the chalk dug from a quarry which has been opened close to the pumping station. It is brought in by a small tramway (Figs. 2 and 3), and is slaked to cream of lime. This is done in two slaking mills in which the lime and water are mechanically stirred together. The "cream" flows from these mills into a storage cistern (Figs. 2 and 3). From this it is pumped to the two lime-water cylinders (Figs. 1, 2, 3, 4, 5, 6, 7 and 8), in which the saturated solution of lime, or lime water, is prepared. Pure water will take up only a small quantity of lime in solution (88 grains to the gallon), and hence a comparatively large quantity of lime-water, about 10% of the quantity of water to be treated, has to be prepared. From the soft water pressure main a branch is brought back to a supply cistern (Figs. 6 and 7). From this a 5-in. pipe leads into each lime-water cylinder, its delivery being controlled by a ball valve. The soft water enters

(a) These results may be converted into grains per imperial gallon by multiplying the figures in the table by 7-10. The same operation transforms the above hardness into degrees of hardness on Clark's scale.

at the bottom of the cylinder (Fig. 1) and rising through the cream of lime, which is pumped in, is drawn off as lime-water by the collecting pipes (Figs. 7 and 8) near the top. To insure complete mixing a rotating stirrer (Fig. 7) is occasionally set to work, driven from the engine in the mechanic's shop through the line shaft along the side of the building (Fig. 2). The outlet pipe from each lime-water cylinder is fitted with two valves. One is used in ordinary daily work to shut off the supply when required. The other is a regulating valve, and is set in the first instance to give the proportion of lime-water which a test, easily made, shows is required to effect the removal of the temporary hardness of the water. The permanent hardness, that caused by the sulphates of lime and magnesia, cannot be reduced by lime-water. It will be seen from the plan that there are two cylinders in place, and that space is provided for two others.

As already stated, the lime-water and the hard water meet in the mixer, and after passing the baffle-plates flow through the distributor to the softening cistern, and from that to the filters (Figs. 9 and 10). Each filter is complete in itself, with inlet, outlet, waste, etc., all the handles of the valves being grouped together, so that the attendant can manipulate them without moving from one position. The filtering of the treated water is a difficult matter, as the deposit is so fine and close that it clogs the filtering material with great rapidity. It is necessary that it should be removed at very frequent intervals; for if not, the process absolutely stops. A thin layer of carbonate is an advantage, as in itself it forms an almost ideal filter, its interstices being so fine that not a trace of turbidity can find its way through, but as it thickens the flow of water grows less and less until it finally ceases. It is therefore imperative that such a type of filter should be used as can be cleaned rapidly with little or no expense for labor.

The Atkins filtering material is woven cloth, at least this is the foundation upon which is carried a fine layer of carbonate which does the actual work. The cloth is stretched over a disk of perforated zinc, which is applied to a plate of cast iron covered with radial and circumferential grooves. A number of these cast iron circular plates, with a disk of zinc and cotton cloth applied to each side, are threaded on a hollow shaft (Fig. 9) and fixed in the filter tank (Fig. 10). Each circle of cloth is held in place at the periphery by a clip ring extending round the cast iron disk, and at the center of the loose collar (Fig. 9) placed between the adjacent disks. The water finds its way through the cotton cloth and the perforated zinc, into the grooves, down which it runs, until it passes through a slot into a central hollow shaft. At the extremity of this shaft, outside the filter tank, there is a double branch, each part being commanded by a valve (Figs. 10 and 11). One branch is a by-pass to the waste, while the other goes to the soft water delivery main.

Let us suppose a filter has been working some time and needs to be cleansed. The attendant, by means of the long lever at the top of the tank, closes the inlet valve (Figs. 1, 2, and 9), and then opens the waste, this latter valve being kept open by the detent, which can be kicked out when required, as its tail comes up through the floor plates (Fig. 9). He then shuts the branch to the soft water main, and opens the by-pass. All is now ready for the cleaning operations. By slackening the screw (Figs. 9 and 12) by which the hollow shaft is pinched up against a leather collar on the tank, the shaft is set free to be rotated by the spur and bevel gear shown in Fig. 9, and on the clutch being engaged, the shaft, with all the filter disks, commences to rotate. Water is then admitted to the spray pipes. The main spray pipe is shown to the right in Fig. 10, and from it there are branches as subsidiary pipes, situated between each pair of filtering disks. The spray pipe is carried in bearings, and by means of simple gearing not shown in the engravings can be raised or lowered to deliver the jets anywhere between the center and periphery of the disks. As these latter are in rotation, it follows that they are completely washed all over, and the carbonate is flushed down the waste.

All is now ready for a return to work. The waste is closed and the inlet opened. Immediately the water pours through the cloth, and for the first minute or two some carbonate accompanies it and escapes through the by-pass. But rapidly a layer of deposit forms on the cloth, when the filtrate runs clear, and is diverted to the main, ready for distribution for the consumers.

If we have made the description clear it will be seen at once that the process proceeds very nearly automatically. The labor involved is that required for cutting chalk; burning it in a kiln at the rate of half a ton a day; emptying the kiln and tipping the quicklime into the slacking mills; and cleaning the thirteen filters, an operation that occurs for each every 6 or 7 hours.

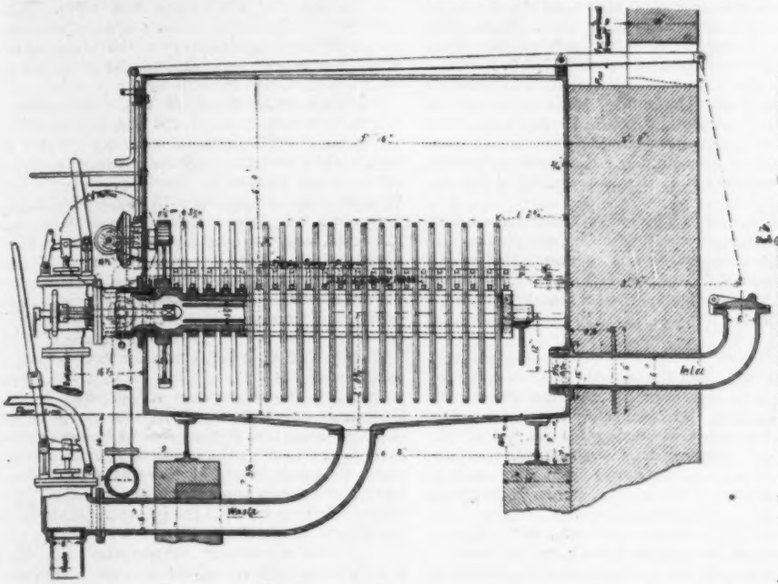


Fig. 9.

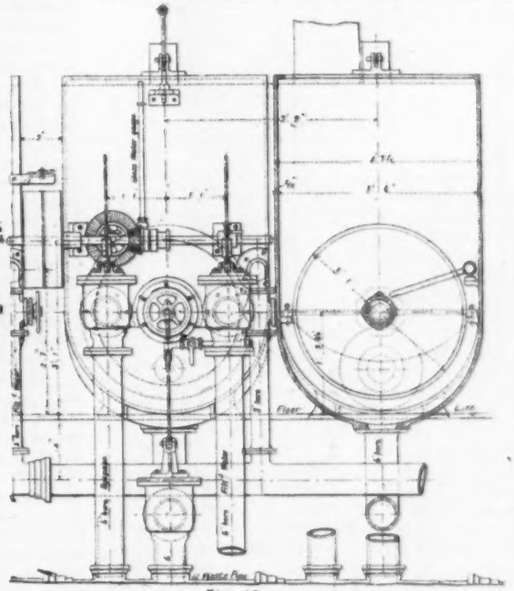


Fig. 10.

FILTERS FOR WATER SOFTENING PLANT AT SOUTHAMPTON, ENGLAND.

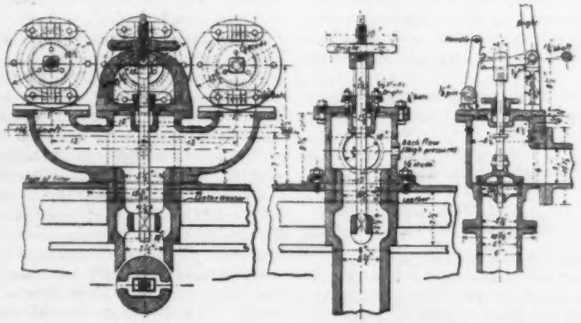


Fig. 11. Fig. 12. Fig. 13.

DETAILS OF VALVES FOR OPERATING FILTERS.

The only material required, apart from the chalk, is the coal needed for the kiln, and this is not much since, as we have stated, the entire cost for material and labor is less than a farthing per 1,000 gallons, or $0.00 per day. Since it has been testified by M. Soyer, the cordon bleu, as well as by Professor Clark, that in making tea with hard water an increased expenditure of 40% is required, as compared with soft water, it is evident that in Southampton the cost of the softening process, including interest and ground rental, is covered many times over by the saving in the teapot. Putting the average weekly expenditure for tea per family at one shilling with hard water, and at eightpence with soft water, then Southampton will be the gainer by about two hundred pounds a week. Again, in Glasgow it is often asserted that the diminished expenditure of soap, consequent on the use of the soft Loch Katrine water, enables each housewife to save her water rate out of the washing tub. It would be easy to multiply instances of other economies, until the water rates would appear insignificant by contrast. The wonder is that so many towns bear the infliction of hard water with such patience.

The cost of the softening plant at the Southampton Water Works was about 10,000 pounds ($48,500). It was erected under the superintendence of Mr. William Matthews by the Atkins Filter & Engineering Co., Limited, from the designs of Mr. Walter George Atkins, Chancery Lane, London.

The annual report of the Thomson-Houston Electric Co. contains the following statement of the growth in electric lighting and railway systems, established by the company:

	Electric lighting:			Electric railways:		
On Jan. 1.	Companies.	Arc lamps.	Inc. lamps.	Companies.	Cars.	Miles track.
1883...	5	365	..	..	..	..
1884...	31	2,478	..	..	..	..
1885...	50	5,867	..	..	..	..
1886...	100	13,227	..	..	..	..
1887...	171	21,840	11,275	..	..	..
1888...	305	36,996	79,350	..	..	..
1889...	419	51,621	120,380	..	..	..
1890...	587	68,203	281,355	92	701	420
1891...	735	87,131	616,335	145	1,532	1,160
1892...	873	100,296	806,500	204	2,769	2,364

The business done from the Boston office of the company has increased from $426,988 in 1883, to $10,304,580 during the past year. The total value of the company's assets, estimated on a very conservative basis, is given as $20,263,448.

THE COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR LIGHTING.

XV.*

THE COMPARATIVE SAFETY OF GASOLINE CARBURETERS.

(Concluded.)

Passing from the record of experience, which, it must be admitted, is not yet sufficiently extensive to be decisive either way, we proceed to summarize the technical facts bearing on the question of probable permanent safety.

1. Gasoline is not a simple fluid like water, in which every particle has the same boiling point, but a mechanical mixture of the "paraffine series" liquids (Eng. News, April 18, 1891, p. 362), in which the separate particles have different boiling points. When heat is quickly applied the whole mass assumes a mean boiling point (for 88° B. gasoline about 110° F.); when heat is slowly applied the lighter parts evaporate first.

2. Much commercial gasoline of so-called 88° Beaumé gravity is really of lighter gravity. In Baltimore the commercial 88° gasoline is mostly 91°, boiling at 83° F. under 3 lbs. pressure.

3. Gasoline is one of the hottest of combustibles, owing to its high proportion of hydrogen and lack of any non-combustible elements. It generates in combustion about 27,400 heat-units per pound, turpentine, for example, only generating 20,110 h. u. and coal or pure carbon some 14,500 h. u.†

This amount of heat is sufficient to convert 24¾ lbs. water at 72° into steam at 212°, about twice the heating capacity of ordinary coals.

3. The latent heat absorbed in vaporization by gasoline from the liquid at 72° F. to steam at atmospheric pressure is low, about 1-5 (19%) only that of water.‡ Therefore the heat produced by the combustion of 1 lb. of gasoline will convert into steam about 5 times as much gasoline as water, or exactly 24.75 ÷ 0.19 = 130.3 lbs. of gasoline. Something less than 1% of the heat of combustion, therefore (exactly 0.77%), if applied to vaporization, will maintain a continuous supply of gasoline vapor, without any assistance from an air supply. In order that the vaporization may be sufficiently rapid to make a good light, however (see first article of this series, April 18, 1891,) a temperature of 80° to 90° or more is required and obtained.

4. The heat absorbed by vaporization at any given rate is sensibly the same, whether it takes place above or below the boiling point of gasoline. Also,

5. The total heat absorbed by the process of gas making, including that needed to warm up the air supply, is sensibly the same at any given rate of vaporization; whether the amount of air supplied be much or little, and whether the vaporization takes place above or below the boiling point. With about ⅛ air and ⅞ gasoline, as in our burning tests (Eng. News, April 25, 1891, p. 392), about 0.79% (i. e., 0.79 of 1%) of the total heat of combustion is absorbed in gas making; with ⅛ air and ⅛ gasoline, 0.81%; with ⅞ air and ⅛ gasoline, 0.83%. All the rest of the heat, say 99.17%, is either carried off in the gases from the chimney or dissipated by radiation from the carbureter or goes to raise the temperature of the carbureter.

6. Whether or not vaporization takes place below the boiling point depends, therefore, on (1) how much of the heat of combustion is communicated to the carbureter; and (2) on how much is radiated therefrom. If more is supplied than is radiated, the temperature will in time rise above the boiling point of say 110°.

7. The mass of the carbureter is very considerable in proportion to the heat supplied to it; but, on the other hand, its mean specific heat is low (about 0.17; water being 1.0). Its total weight, including the casing and attachments, being 160 lbs.;* 27.2 h. u. only (160 × 0.17) are required to raise its temperature 1° F. To raise its temperature from 83° F. to 113° F., (the boiling point of gasoline under about 3 lbs. pressure), or say 30°, requires 816 h. u.

8. The total generation of heat under the conditions of our burning tests† was 6,938 h. u. per hour, of which 0.79%, or 55.78 h. u., is absorbed in generating the gas. If, in addition to this heat of vaporization, we assume various percentages of the total heat from 1% to 30%, to be communicated to the carbureter *in excess of that carried off by radiation*, we find that the carbureter will be heated up from 83° to 113° F. (i. e., absorb and retain 816 h. u.) in the following time:

The percentage of total heat communicated, in excess of 0.8% for vaporization and of the loss by radiation, being

1%	2%	3%	4%	5%	10%	20%	30%

and the heat units per hour represented by these percentages being

69	139	208	278	347	694	1,388	2,081

816 h. u. will be communicated to the carbureter in

11.82 hours.	5.91 hours.	3.94 hours.	2.96 hours.	2.36 hours.	1.18 hours.	0.59 hours.	0.59 hours.

Two actual tests of lamps burning in still air of 75-77° in a large room (Eng. News, Aug. 15, 1891) showed that 3¾ to 4 hours was required to raise the temperature of the carbureter 42°, indicating that under those conditions 2½ to 3% of the heat generated in excess of the loss by radiation and vaporization was communicated to the carbureter. With the surrounding air in rapid motion the radiation would be many fold more rapid; with still air at 38° F. radiation would be about twice as rapid. With the exterior shell of the carbureter heated to 112° radiation would cease. Between these extremes there may be all conditions of radiation.

The above computations apply to lamps burning gasoline at the rapid rate of 4.05 oz. per lamp per hour. In Pennsylvania R. R. practice it has been found that about 3.3 oz. per lamp per hour=(1 qt. per hour for six lamps) is burned. At this rate, the above computed times for heating up the carbureter 30° should be increased about 22½%; in addition to which it is to be remembered that the Pennsylvania plant does not direct nearly as much heat into the air passages surrounding the carbureter as do the forms of plant tested. At half this rate of combustion, which we assumed in our article on comparative cost to be a fair vaporizing rate for ordinary practice, about twice as much time would be required as is above computed to heat up the carbureters 30°, under otherwise similar conditions.

These facts point to the conclusion that in wintry air in rapid motion it might be all but impossible to raise the temperature of the carbureter 30° F. above the temperature of the interior of the car in any form of the plant; that, in still summer air, or in strong sunshine, even with rapid motion and with no lamps burning, it might be very easy to do so; and that between the two there may be all conditions, according to whether the car is moving or standing still, in cold or warm weather, and hot or cold inside. Experience on the Pennsylvania R. R. has shown that there is a considerable loss of gasoline through the safety valve in summer. This is believed to occur in the daytime as an effect of sunshine, but there is no experimental evidence of that fact. It may occur largely or chiefly in warm night air when the lamps are burning.

We have so far regarded the carbureter as a whole, including its sheet iron and pasteboard exterior non conducting shell, weighing 102 lbs., between which and the carbureter proper a current of warm air circulates. Considering only the carbureter proper, weighing with its contents 58 lbs., it requires, as a brief computation will show, some 15.9 h. u., only to raise its temperature 1° F., as against 27.1 h. u. for shell and all. It will, therefore, take but little more than half as much heat (59%) to communicate 30° of heat to the whole of the carbureter proper, as to carbureter, shell and all, or half as much heat if the time be constant.

Finally, and what is perhaps the most important consideration of all, the heat is not applied uniformly even to the carbureter proper, but is most intense at the bottom and interior core. The observed temperature of the gases which pass up this core* is 250° to 600°; the air from the car entering above the smoke-bell is at times heated to 150° to 175° F. Moreover, the effect of the wicking, which serves primarily to avoid the presence of gasoline in liquid form, also serves to dissociate the mass of absorbed liquid and prevent that free circulation which in a liquid forbids part of it from boiling until all is heated to the boiling point. Part of the gasoline, therefore, may be heated above the boiling point and thus may be generating steam while the rest of it is comparatively cool.

As a homely illustration; conceive a wet sponge held against a hot stove pipe. The interior part will give off steam and rapidly dry while the exterior is still cool and can be held in the hand.† To make the illustration more perfect, conceive an annular sheet iron reservoir packed with sponge saturated with water to be built around a stove pipe; conceive also that there are two small openings in the top of this reservoir, one near the stove pipe, and the other near the outer part of the disk. If the stove pipe be hot enough to make steam at all, will steam begin to come out of the inner opening almost at once, or will it wait until the entire mass of sponge and water within has been heated to the boiling point? We conceive that it will begin to come out at once, and continue indefinitely to come out, chiefly through the inner opening; and this all the sooner if the interior mass be cut up by a spiral partition.

It is true that the core of a carbureter is by no means a stove pipe; but it is separated only by an inch or so of non-conducting air through which radiant heat will readily pass from a pipe which is nearly as hot as an ordinary stove pipe; and then, gasoline is not water. We therefore conceive that this unequal temperature of different parts of the interior is precisely what takes place during the greater portion of the time when carbureters are burning, in any form of the plant; and this conclusion is not greatly affected by whether a part or all of the air supply works its way to the burner through the wicking or takes the short cut above the carbureter through the by-pass.

For reasons given in detail in our issue of Aug. 15 (p. 138), however, we have grave doubts whether in ordinary practice much air ever works its way through 42½ ft. of spiral passage filled with wicking instead of taking the short cut through the by-pass. The standard by-pass is (or was) the same for all forms of the plant. It will, by experiment, pass about 5.87 cu. ft. per hour under ¼ oz. (0.43 in

---

*The previous articles of this series, which is concluded with this issue, have been as follows beginning in 1891:

I.—April 18, Introductory; nature of illuminants.
II.—April 25, Photometric instruments; burning tests.
III.—May 2, Frost carbureter plant; descriptive.
IV.—May 9, do.; the carbureter.
V.—May 16, do.; tests of strength of carbureter.
VI.—May 23, do.; charging carbureters, etc.
VII.—Aug. 15, do.; tests of functional action.
VIII.—Aug. 22.—Pintsch compressed gas; gas making.
VIII.—Aug. 29, do.; storing and distribution.
IX.—Sept. 5, do.; plant on car.
X.—Sept. 19, Oil burning lamps.
X.—Sept. 26, do.; oil tests, etc.
XI.—Oct. 10, do.; construction of lamps.
XI.—Oct. 17, do.; additional notes.
XII.—Nov. 14, Electric lighting; storage batteries.
XII.—Nov. 21, do.; English practice.
XII.—Dec. 5, do.; American practice.
XIII.—Dec. 19, Photometric tests and records.
XIV.—March 12, 1892. Comparative first cost.
XV.—March 26, Comparative safety; oil gas.
XV.—April 9, do.; oil lamps.
XV.—April 9, do.; gasoline carbureters.

[A republication in book form of this entire series of articles will be issued on or before May 1; price $1, post paid. Prior to April 20 notes of typographical or other corrections in any of these articles will be welcome, and receive attention.]

†The following gives the chemical composition and heat generating capacity of a few of the hotter combustibles:

Substance.	Chem. comp	P. c. hyd.	H.u. per lb.	Evap. lbs.
Gasoline	$C_7 H_{16}$ to $C_8 H_{18}$	about 27.3	27,520 to 27,300	24.75
Turpentine.	$C_{20} H_{16}$	11.8	20,110	18.2
Alcohol.	$C_2 H_6 O_2$	14.3	12,929	11.7
Olefiant gas.	$C_4 H_4$	14.3	21,330	19.3
Pa., crude petr'm.	$C_{36} H_{12}$ (etc.)	13.	20,240	18.3
Carbon.	C	0 0	14,544	18.3

The per cent. of hydrogen for alcohol is for the combustible hydrogen only, excluding that which combines with the oxygen. The evaporation is in pounds of water at 72° into steam at 212°, absorbing 1,106 h. u. per lb. of water.

‡According to the best available authorities gasoline absorbs only 150° per lb. in the actual process of vaporization or 199° from liquid at 72° to steam at (say) 112°, or 17½% of that of water, which absorbs 1,106°. As there is some doubt upon this point, however, we take the total heat to be 210° instead of 199°. We cannot learn that any tests have ever been made on gasoline. Prof. J. K. Denton, of the Stevens Institute of Technology, writes us as to existing records: "The only experiments with anything resembling naphtha, are to be found in the third volume of Regnault's (Experiments) or 'Compte Rendus' about 1843. I understand, however, that what he calls naphtha is not identical with what is now used under that name. The only experiments on this substance are those reported Art. 135, Wood's 2d ed. 'Thermodynamics,' where the latent heat is given as 237 thermal units per lb. for a pressure of 60 lbs. above the atmosphere. The figure is an approximate one, as the degree of superheating present was not accurately determined, but it is probably not largely in error." This figure would give a considerably lower heat of vaporization than that estimated above (210°), which is based on data given in D. K. Clark's "Manual for Mechanical Engineers."

*We refer always to the original circular carbureter. The newer square form is larger and heavier.

†Eng. News, April 25, 1891.

*Eng. News, Aug. 15, 1891, p. 137.

†The fact that 3 lbs. pressure exists in a carbureter makes no difference, except to slightly raise the boiling point, since the same pressure exists inside and out, less a trifling correction to be noted shortly.

of water) pressure, and half that quantity, or some 2.93 cu. ft. under one-fourth of that pressure, or 1-16 oz., which is practically no pressure at all. The usual air consumption, in plants which use most air, is 2 to 3 cu. ft. of air per hour. It may be that a pressure of 1-16 oz. will force a sensible quantity of air through the spiral passages, but we doubt it.*

These several conditions seem to point to the following conclusions:

A. A very slight difference in the amount of heat present, with hardly any difference in the amount of heat absorbed or radiated, may change the plant from one which charges air with cool gasoline vapor to one which mixes gasoline steam with a varying supply of air, or vice versa.

B. In either case this does or may take place to a considerable extent in the pipes outside of the carbureter, and it is not functionally necessary that any air should pass through the carbureter passages, to make gas.

C. In either case, but especially when any part of any of the carbureters is heated above 110-15°, a rupture of the deck pipes, carbureter connections, carbureters, or interior gas pipes between the carbureters and needle valves is likely to let out an inflammable or explosive gas, and not air only; which gas will continue to come out with some freedom until the temperature of every part of all the carbureters has fallen below 110°, and thereafter more slowly.

D. In either case, but especially when the carbureters and interior of the car are quite warm and the exterior air is cold, after the lamps are extinguished for the night there will be a generation of vapor which will tend to condense in the deck pipes and remain there until the lamps are again lighted. If the deck pipes were entirely filled by this condensed gasoline, as may happen at times, there would be nearly two-thirds of a gallon of gasoline contained therein (enough to supply one lamp for some 17 hours), which would escape as liquid or vapor in case of rupture.

E. If there be any leakage of air about a carbureter, it is essential to safety that if one lamp on a car be lighted all should be lighted; if one lamp be extinguished (for any considerable time) all should be extinguished. Otherwise, the entire interior of all the carbureters on a car and their connecting deck pipes being a single closed chamber, and there being a slow escaping current through the leak, gasoline will tend to distill over from the lighted carbureters and to condense in the unlighted and hence cool, leaky carbureter, which may then become overcharged with liquid gasoline.*

We should be reluctant to express these conclusions about a problem which involves so many complex elements as the precise functional action of this plant, if their correctness did not admit of simple proof or disproof, by a variety of tests, all of which can be made without special apparatus, or much loss of time, or sensible injury to the plant on any car. The tests of this nature which now occur to us, and which are applicable to all forms of the plant alike, are the following:

1. Tap a common gas burner into the deck pipe near a carbureter. Light all the lamps and let the surrounding air be moderately warm. If the accepted theory of the plant be correct, nothing should issue from this burner at any time except air, with perhaps a smell of gasoline. If our theory of the plant be correct, an inflammable gas will issue after the parts are once well warmed up, which will continue to burn indefinitely. If so—

2. Tap in more gas burners in various parts of the deck pipe until it is found that they will not all continue to burn after the parts are well warmed up. If our theory of the plant be correct, the number will be very considerable under favorable conditions. Also—

3. After one or more of these exterior burners are lighted and the carbureters are well warmed up, extinguish all the interior lamps and note how long it is before the exterior burners will go out. If our theory of the plant be correct, it will be a very considerable time under favorable conditions; but with the exterior air colder than 75° to 80°, it will not be long.

4. On a cold day, after burning all the lamps at full height four or five hours in a warm car, stand the car on a slight grade and observe through a cock tapped into the lower end of the deck pipe whether any liquid gasoline can be drawn out. If our theory of the plant be correct some liquid should begin to issue soon after extinguishing the lamps.

5. Without lighting the lamps, expose the exterior of the carbureters to a temperature equal to that which may be derived from a summer sun, with 90° interior temperature. If our theory of the plant be correct, deck gas burners under these conditions can be lighted and will continue to burn.

These experiments may be varied and extended in many ways. They will indicate, should they correspond in result with our conclusions, that rupture of any of the pipes or connections at any point during much of the time when the car is in service, either by day or by night, will not let out air only, but will let out a considerable volume of inflammable liquid or gas, which sinks in air and tends to adhere to clothing or collect in pools, and if any part of it reaches fire anywhere becomes highly dangerous.

The same result will follow, "a fortiori," from any cause which should rip open a carbureter bodily, exposing its wicking freely to the air. That this is extremely difficult to do and that the carbureter is extremely tough and difficult to rupture was shown by experiments detailed at length in our issue of May 16, 1891. These tests have been accepted by many presumably competent authorities, as conclusive proof that under no conditions is a carbureter likely to be torn open in a wreck. We cannot quite agree with them. We agree that these tests showed that it was far more difficult than one would expect to tear open a carbureter injuriously in a wreck, and that it is only in very severe accidents that it is likely to happen. But we do not consider that the test conditions were as severe as they might be made, or as may occur in a passenger collision, and in rare cases we believe it will be found that the carbureter will be so sheared or torn as to expose much wicking to the air—a fact which would be of little moment (because of its rarity) except that when it does happen, if it ever does, will be just when most lives are exposed to the danger of a painful death.

Other dangers of accidents from lamps in service, however, such as "explosions" and the like, we believe are, practically speaking, wholly absent from the plant, contrary to our impressions on beginning this investigation. But besides accidents from lamps in service there are a number of other possible sources of accident which we merely enumerate, and leave everyone to estimate for himself, since the estimate cannot possibly be made precise. The most considerable of these is perhaps—

1. The possibility of inexpert tampering with the details of construction or operation, as by using a lighter gasoline,* turning more heat around the carbureters,† varying the construction of the carbureters, modifying the rules for charging,‡ etc. It is evident that such changes may seriously modify the functional action of the plant, and perhaps injuriously.

2. Gasoline will naturally be kept in stock at a good many points, and in as small quantities as possible, to avoid the risk of fire. It will therefore tend to be transported on a good many different trains, and quite possibly at times in passenger trains, in response to telegrams for a supply to some officials' car, or to meet any other unexpected emergency.

3. The dangers of fire and explosion from free gasoline being quite outside of the ordinary experience of ordinary trainmen, it will be impossible to make a large staff appreciate duly with what care it should be handled, especially after a long period of immunity.

4. The stock being naturally kept in a small detached building, at a point convenient for charging, a leak in any one of 80 or more 2-gallon charging cans may generate a gas which any flame may ignite and cause a sudden and fierce fire in the middle of a large yard. This is especially possible if the building be a mere sheet iron shell such as is largely used and recommended.

5. Carelessness in charging, especially with lanterns or locomotives near, may cause a fire.

6. Leaks in the plant on the car at any point may have serious consequences.

These various facts and possibilities lead us to feel grave doubts as to the propriety of using gasoline as an illuminant for cars, even in that safest of all devices ever designed for burning it, the Frost carbureter plant. This seems especially so because it does not appear from any facts known to us and recorded in these articles that the carbureter furnishes either a better or a cheaper light than can be obtained from 300° oil or from compressed oil gas. But in closing this long series of articles we desire to say again, as we have said before, that a case can be made out in favor of the safety of that system for general use so strong that, if not strong enough to withstand all tests of a rigid investigation, is at least so strong as to make it pardonable for any man to have believed it invincible and acted accordingly. Many railway officials of the highest character and standing, having a responsibility on their shoulders which we have not, have so acted and so concluded. Should the worst railway holocaust on record occur to-morrow and be directly traced to the use of gasoline for car lighting, we shall have no word of reproach to say to them nor of them. Should such an accident occur two or three years from now, however, unless we have obtained more light in the meantime than we now have as to some of the difficulties suggested in this article, it may be a different matter.

* There is an easy way to test this conclusion, by attaching a pressure gage to the gas pipe between the carbureter and needle-valve. If it indicates more than ¼ to ⅛ oz. less pressure than exists in the deck pipe, then the by-pass will pass much less air than our experimental tests indicated, and perhaps so little that a certain percentage of air (which may be large or small), is going through the wicking. Whether air thus passes or not, however, does not affect our main conclusions, except that the exit of gasoline vapor from the "air inlet" will be opposed by a pressure equal to some fraction of the difference observed.

† The most probable explanation of the Georgia Central instance of imperfect action of the plant, as above given, seems to us to be that it was an instance of this distilling effect.

* This has already occurred; a lighter gasoline boiling at 91° being supplied at many points.

† This also has already occurred, and in a way which many strong friends of the plant regarded as highly injurious. After the original experiments on the Pennsylvania R. R. had been completed, and standard plans for that road adopted, the manufacturing company proceeded to make some considerable changes in the functional action of the plant, which have been fully explained in these articles, by the apparently simple change of adding a damper which threw much more heat around the carbureters. It developed in the course of this investigation that a considerable number of these modified lamps had been placed upon the cars of the Pennsylvania R. R. in the ordinary course of business, without the knowledge or consent of the responsible officers, who thereupon ordered them removed.

‡ Both the construction of and the rules for charging the carbureters have been considerably modified since the first introduction of the plant.

ELECTRICAL TRACTION.

At a late meeting of the English Society of Engineers, Mr. Stephen Sellon read a paper with the above title, bearing upon the main features and claims of the several systems: Mr. Sellon points out that the well-known systems of electrical traction before the public are the following: (1) Accumulators consisting of E. P. S., and the Julien types. (2) Overhead consisting of the Thomson-Houston, Edison, Sprague, Short, Rae, United Electric Traction Co., Daft and Van Depoele types. (3) Conduit consisting of the Lineff, Gordon and Wynne types for closed conduits; and the Waller Manville and Blackpool types for open conduits. The paper is abstracted as follows in the "Railway News," of London, but we have changed the English money into American:

After dealing with each system, Mr. Sellon thus summarizes the commercial aspect of the case: Being entirely governed by capital cost, working expenditure, and depreciation, a hypothetical case of three miles of tramway is taken and as it is very difficult to apply the cable system to a single line with passing places, a double track example is taken, and one gradient of 1 in 20, 880 yds. long in the center of the system is assumed. It is proposed to furnish the same with an equipment sufficient for a ten minutes' service by horse cable, or electricity including the overhead and conduit systems. The capital cost and average working expenditure of each system has been carefully compiled from such detailed information as has been obtainable, and is verified by the author's own personal knowledge and experience.

In the estimates of capital cost any allowance for depot buildings and land has been excluded, as, although the figures would show somewhat in favor of mechanical systems, they might be taken for this purpose as costing about the same in each case, and as the value of land varies in different localities and the cost of a depot is a very variable item in accordance with the class of work which may be put into it, it is better on the whole to exclude this item. The capital cost

expended on the construction and equipment of a horse line may reasonably be taken at $129,000, of which $105,000 represents the cost of the tramway, and the balance the equipment.

In dealing with the mechanical systems it is assumed that the cost of the construction of a horse line should be added to the cost of converting the line and equipping it on the respective systems of mechanical traction, and it has not been thought fair to charge these systems with any portion of the cost of the horse equipment, because the equipment should represent its full original value if a proper sinking fund has been provided, and on this basis the capital cost of horse, cable, overhead and conduit lines is estimated as follows:

Capital cost of horse line....	$129,000	exclusive of depot	
" " overhead line..	169,000	"	"
" " conduit line....	217,500	"	"
" " cable line.....	220,000	"	"

In regard to the working cost of these systems the figure put down (which in each case includes a reasonable allowance for maintenance and repairs) has been arrived at, as regards the horse line, from the large amount of information which is available on the subject. As regards cable traction, the last balance-sheet of the Birmingham Central Tramway Co.'s cable system has been taken, and the figures which they give have been adapted to the example given. It is necessary to point out that the efficiency of a cable tramway depends in an exceptional degree on the car mileage, which in Birmingham is very large. The figure arrived at in this case has been checked by reference to American statistics and by other means, and it may be considered as a fairly accurate estimate; at any rate it would not be safe to assume that a cable line of this size and with the specified service could be worked at a cheaper rate than that given later on. In the two electrical systems the actual details of the cost which would be involved have been very closely gone into. The estimates given are very sufficient, and there can be no reasonable doubt whatever that such a line could be worked at the price stated. There is no appreciable difference in the cost of working an overhead and a conduit system. It should also be stated that these estimates, besides including maintenance and repairs, as above stated, also include the cost of the car drivers, which is a very considerable amount, and is not infrequently omitted in cost of estimates of traction. The following are the figures, the rate per car mile being based on car mileage of 197,000 per annum:

	Per annum.	Per car mile.
Cost of working horse tramway...	$28,750	equals 14 cts.
" " cable tramway...	28,750	" 14 cts.
" " overhead tram'y..	16,000	" 7.8 cts.
" " conduit tramway.	16,000	" 7.8 cts.

In order to compare the relative conditions of working with horse or with one of the mechanical systems referred to in the preceding estimates, it is assumed that in order to raise the extra capital required for each of the mechanical systems over and above the capital necessitated for a horse line debentures must be issued at 5 per cent., so that the original capital for all the systems will be the same as for a horse line, and this capital has been taken at $175,000, being an extra sum of $46,000 to cover the cost of depots and working capital beyond the figure of $280,000 included in the preceding estimate. The amount of debentures to be issued would, therefore, be as follows:

			Per annum.
Overhead line....	$31,000	equal at 5 per cent. to	$1,550
Conduit line.....	78,500	" " "	3,925
Cable line.....	111,000	" " "	5,550

The debenture interest must, therefore, be added to the working cost of each of the mechanical systems in order to compare them directly with a horse line. We, therefore, have the following figures of working cost:

	Ord. working cost	Debenture interest.	
Overhead line.....	$16,000	plus $1,550	equals $17,550
Conduit line.....	16,000	plus 3,925	equals 19,925
Horse line.....	28,750	minus	equals 28,750
Cable line.....	28,750	plus 5,550	equals 34,300

These preceding figures show that for a line of this description a cable tramway is more expensive to work than a horse line after making provision for the debenture capital involved by the cost of reconstruction. The following figures show the amount saved per annum by the overhead and conduit systems compared with a horse tramway:

Overhead.....	$28,750	minus $17,550	equals $11,200
Conduit.....	28,750	minus 19,925	equals 8,825

and these amounts show an increased dividend available on the ordinary share capital, $185,000, upwards of 6 per cent. per annum in the case of the overhead line, and upwards of 5 per cent. per annum with a conduit line.

A DROP TEST OF NICKED STEEL.

In our issue of March 26, in publishing an abstract of Mr. F. H. Lewis' paper on "Soft Steel in Bridges," we called attention to some very interesting tensile tests on full-sized eye-bars which were upset and joined by a turnbuckle connection. The importance of this test lies in its bearing on the question whether a surface injury to a steel bar seriously affects its strength or reliability. There are those who hold, we believe, that even a slight scratch of a cold chisel or a bruise from a sledge on a steel bar may lead to its failure under a light load or a moderate shock. As we then said, a screw thread on a rod is practically a nick and a good deep one all round it, and we may add that in the tests described the thread was cut on a bar which in upsetting had its section changed from a rectangle, 5x7/8 ins. in size, to a circle.

The results of these tests showed that cutting the screw thread did not injure the metal beneath, at least so far as a steady strain was concerned. But the engineer who holds that all steel retains something of the brittleness which characterizes cast iron, may object that the injury done by cutting the thread was not developed by the steady strain; but would have shown itself if the piece had been used where it was subject to impact.

Through the courtesy of Mr. F. H. Lewis, our attention was called to the fact that tests had been made by the Union Bridge Co. in the hydraulic testing machine at their Athens, Pa., shops, covering this last named point. The tests were made by putting a full-sized eye-bar, joined with a turnbuckle connection, under a strain far beyond its elastic limit, and while under strain, dropping a 1,000-lb. weight repeatedly on the side of the bar. As Mr. Lewis well says, in his letter, "It will hardly be claimed that impact in bridge structures produces any such effect as this. In fact nothing short of a collision with the truss could produce anything like it."

In response to our inquiry the Union Bridge Co. has favored us with a copy of the report giving the results of this test, which we reprint with the accompanying letter, as follows:

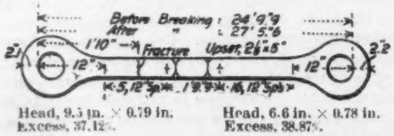
Sir: We enclose copy of report of test of full size steel counter, referred to by Mr. Lewis. We think the remarks will sufficiently explain the peculiar feature of test.

In addition to this, we made a similar test of a 1 1-8 in. round steel lateral rod with upset, and nut on each end. The memorandum of the latter test has been mislaid, but we can say that the result was perfectly successful in demonstrating that a steel upset screw-end is able to stand all the abuse it is likely to receive in regular use. We very much doubt if an iron counter, or rod, can be made to give as good results, within the limits of strain the iron rod can sustain.

Yours truly, R. D. Wilson.
Manager Athens Shops, Union Bridge Co.

Test No. 1795; Order No. 863; Heat No. 41,961, long end; 41,853, short end. July 21, 1891.

Full sized test of steel counter with sleeve nut; rolled by Cambria Iron Co.; manufactured by Union Bridge Co.



Head, 9.5 in. × 0.79 in. Excess, 37.12%.
Head, 6.6 in. × 0.78 in. Excess, 38.87%.

Diam. of pinhole, 5.52 ins. Diam. of pinhole, 2.52 ins.
Elong. of pinhole, 0.58 ins. Elong. of pinhole, 0.28 ins.
Nominal section 3 × ¾ ins. Actual section, 3.05 × 0.75 ins.
Original area, 2.29 sq. ins.; area at base of threads, 2.60 sq. ins.; fractured area, 2.22 × 0.49 = 1.09 sq. ins.
Gage reading for elastic limit, 47 = 95,850 lbs.
" " " ultimate strength, 75 = 153,935 lbs.
Elongation in 12 ins., including fracture, 3.5 ins.
" 5 ft., 11.3 ins.
" 16 ft., 18.6 ins.
Elastic limit, 41,860 lbs. per sq. in.
Ultimate strength, 66,800 lbs. per. sq. in.
Elongation in 12 ins., 29.17%.
" 5 ft., 18.8%.
" 16 ft., 9.7%.
Reduction of area at fracture, 52.4%.
Fracture, 100% silky at 45%.

Remarks: Elongations after fracture, out to out of holes, as follows: A, 12.7 ins. + 5 ft. 11.3 ins. + 1 ft. 10.5 ins. + 17/8 ins. 6.6 ins. + 12.5 ins. B.

A weight of 1,040 lbs. was suspended over long-end, about 5 ft. from sleeve nut and dropped from the following heights with the rod under various strains as follows:

Strains, lbs. per sq. in.....	50,000	55,000	60,000	63,000	65,000
Height of drop..	2 ft. 1 in.	2 ft. 6 ins.	3 ft.	4 ft.	5 ft.

The same weight was then shifted so as to fall directly on the sleeve nut and the test continued as follows:

Strain, lbs. per sq. in.....	65,350	65,350	68,800
Height of drop.....	3 ft.	6 ft.	6 ft.

The gage was failing when last blow was struck.
R. S. H., Inspector.

GOVERNMENT TIMBER TESTS.

From advance sheets of the report of the proceedings at a meeting of the Engineers' Club of Philadelphia in October, 1891, we abstract the following particulars relating to the government timber tests, the importance of which tests was editorially noted in our issue of March 12, 1892. In previous issues we have described the methods of carrying out the tests:

Mr. B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, said: It is, perhaps, unnecessary to remark, before a body of engineers, that our knowledge of timbers is very imperfect; in fact, "our knowledge of timber may be described as a state of ignorance." Everybody knows that wood is exceedingly variable in its qualities; it is the factor of "life" that makes the quality of wood so variable. While in the manufacture of iron and other building materials, we have it more or less in our hands to make them of given quality, we are not well enough aquainted with the physiology of timber to even recognize its qualities by a simple examination.

The object of the present work undertaken by the Forestry Division is threefold. First, to obtain a better knowledge of the quality of our commonest commercial timbers. Second, to devise means of relating qualities to physical structure and appearance. Third, to establish, if possible, the influence which divers conditions of growth exercise upon the quality. These objects can be attained only by a very large number of tests on material of known origin, carefully examined as to its anatomical structure and physical condition.

We are investigating not only the strength of the specimens submitted, but all other conditions affecting their usfulness in service. Exhaustive records are preserved in duplicate, stating in the minutest detail all the circumstances observed with respect to each specimen; the locality where it was cut, with its geological and climatological features; an exact description of the site and exposure, the soil, the surrounding growth and undergrowth; the origin of the tree, its age and dimensions; the positions in the tree of the various test pieces submitted, etc., and it is expected to subject the regular series of tests from 1,000 to 2,000 test pieces of each species. While from the large number of tests our knowledge of the capabilities of each species and of their range of strength will be advantageously increased, the main and most important, as well as the most difficult part of the work lies in the physical examination of the test material and the relating of the results of the latter to the test results. When we are through with the work, we hope to enable the engineer or architect not only to specify for timber of given quality, but also, by a rapid macroscopic and microscopic examination, to pass on each stick as to its coming up to the specifications, and, furthermore, to acquaint us with the conditions of growth that produce given quality.

While this is the ideal object, attainable probably only in part, it is evident that an enormous amount of new knowledge regarding one of our most important materials of construction must result by the way. The vastness of the undertaking involved in anything like such an adequate series of timber tests points to the conclusion that the national government alone is competent to grapple with it. For while this work has been inaugurated on a small scale with the scanty appropriation for the Forestry Division, it becomes now of the first importance that the means should be forthcoming which alone will enable us to prosecute the work in an acceptable manner, and those who are conducting the tests are now chiefly anxious that the engineers of the country shall make known to Congress, through the Department of Agriculture, their estimate of the importance to the country of the knowledge to be gained, in the hope that the needed appropriation may be granted.

Mr. E. E. Russell Tratman, Associate Editor of Engineering News, said that in regard to microscopic examinations, the value of these will be specially recognized by any one who has read the report of Mr. P. H. Dudley on "The Structure of Certain Timber Ties; Behavior and Causes of their Decay in the Roadbed," which was published in 1887 in Bulletin No. 1 of the Forestry Division. In that report Mr. Dudley stated that the decay of timber, formerly ascribed to slow combustion, is now known to be due to various kinds of fungi, the presence of many of which has been demonstrated by microscopical investigations. These fungi are the indicating causes of decay. The report then considers the structure and nature of some of the timbers largely used for railway purposes. In these investigations the microscopic examinations formed a very important part, and a series of photo-micrographs is given, showing the structure of the different timbers. The report, although dealing only with a limited number of species of timber, is one of the most valuable and practically useful contributions to the literature upon this and kindred subjects. There is a large

amount of published scattered information in regard to the properties and qualities of timbers in this country and abroad, and I suggest that it would be advisable for the Forestry Division to keep a record or bibliography of such published information. The tests should also include timber treated by preservative processes. In this country a very large amount of soft wood is used for railway ties, which has led to the use of steel tie plates under the rail for purposes of economy. With the harder woods this is not necessary. Australia has not to provide such means to increase durability, as the ties are of native hardwood, and the abrasion of the surface is lessened by holding the rails firmly to the ties by bolts as well as spikes.

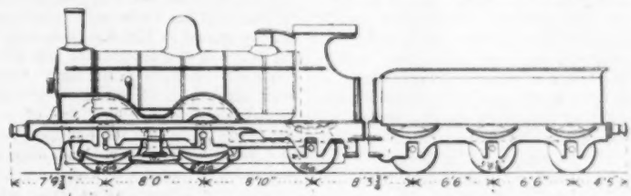
Much has been said of the desirability of having government control of the forest property, and in this connection I have been interested in looking up the review of forest administration in British India for the year 1887-1888. The aggregate area of the provinces under management and control of the Forestry Department 812,700 sq. miles, of which 97,386 sq. miles, or 11%, was forest area, which already yielded about $1,400,000 net return to the government, of nearly $14 per sq. mile. The forests are worked for revenue in a proper business-like manner, a certain output being made of timber and fuel. The protection of the forest areas from fire and cattle has been successfully managed, and the artificial reproduction of forests is encouraged, while experiments are carried on in growing exotic trees, etc. The results obtained in India should be encouraging to those who are working for forest preservation in this country.

NATURAL GAS IN THE SALT LAKE BASIN.

Within sixty days odorless natural gas in almost unlimited quantities, it would seem, has been discovered on the shore of the Great Salt Lake within ten miles of Salt Lake City, Utah. The American Natural Gas & Oil Co., Mr. J. F. Woodman, president, has been incorporated with a capital stock of $5,000,000 to develop this field, and has purchased the belt through which this gas vein, as far as discovered, passes. The other officers are Vice-Prest., L. Martin; Treasurer, W. S. McCornick; Secretary, C. W. Hall, all of Salt Lake City. The services of Major C. F. Doxey, of Anderson, Ind., as an expert, were secured, and he pronounced the gas of good quality, and stated that a sufficient quantity could be secured to permit of its use for manufacturing, heating and lighting purposes. Four 2-in. wells have already been put down, each about 650 ft. deep, from which 50,000,000 cu. ft. of gas flow daily, it is said. Six additional wells will be sunk at once. The new town of Woodman has been laid out on the site of the wells, and railway connection is to be secured by extending the Great Salt & Hot Springs Ry. to this point, as stated in Engineering News of April 9. The "City Council" has granted the company a franchise to lay pipe through the streets and supply gas for heating and manufacturing purposes, and contracts will soon be closed for a pipe line costing $500,000. We are indebted to President Woodman for the above information, and he also informs us that a smelter costing from $1,000,000 to $2,000,000 will probably be erected this year; also that a good quality of silica in large quantities can be secured near by, and the erection of a large glass manufactory is already contemplated. This, so far as we are informed, is the most westerly point at which natural gas has been discovered.

LOCOMOTIVE FOR MIXED TRAFFIC; LONDON & SOUTHWESTERN RAILWAY, ENGLAND.

The London & Southwestern Railway, of England, has a freight mileage not much more than one-third of the passenger mileage, and has therefore brought out a type of engine which can be used for passenger and freight traffic, and which is more suitable for passenger service than the standard type of English freight engine, having six wheels, all coupled. The engines were designed by Mr. William Adams, Locomotive Superintendent, and the following particulars are taken from an article in the "Railway Engineer." There are 30 of these engines now in use, and the performance has been so satisfactory that 50 more are to be built. They are used for all kinds of traffic, express and slow passenger trains, milk trains and ordinary freight trains. They can haul excursion trains of 22 cars, averaging about 12 tons each, or a total train load of 264 gross tons, or 336 tons, including the engine and tender. They also haul trains of 40 freight cars of 10 tons capacity and 6½ tons dead load, a total of 660 tons, or 732 tons, including the weight of the



LOCOMOTIVE FOR PASSENGER AND FREIGHT SERVICE; LONDON & SOUTHWESTERN RAILWAY, ENG.

engine and tender. The heaviest grades are 1.66 per cent. for 2¼ and 3 miles, and 1.25 per cent. for 2 and 3 miles. The engines have inside cylinders, and are carried on four coupled driving wheels and a pair of smaller trailing wheels. The blast pipe is of Mr. Adams' fixed "vortex" type. The leading dimensions and particulars are as follows:

Cylinders	18x26 ins.
Steam ports	1⅝x15 ins.
Exhaust ports	3¼x15 ins.
Distance c. to c. of cylinders	2 ft. 1 in.
Slide valves; max. travel	3 15-16 ins.
Piston rods, diameter	3⅜ ins.
Driving wheels, diameter	6 ft. 0 ins.
Trailing wheels, diameter	4 ft. 0 ins.
Driving axle journals	8x8 ins.
Trailing axle journals	6½x11 ins.
Wheel base, driving	8 ft. 0 ins.
Wheel base, total	16 ft. 10 ins.
Boiler (steel) diameter of barrel	4 ft. 4 ins.
" length of barrel	11 ft. 0 ins.
" thickness of barrel plates	½ in.
" height from rail to center line	7 ft. 6 ins.
Working pressure	160 lbs. per sq. in.
Firebox (copper), size at grate	5 ft. 3⅞ in.x3 ft. 2½ ins.
Tubes (brass), diameter outside	1¾ ins.
" thickness	Nos. 11 and 13 B. W. G.
" pitch	2⅜ ins.
" length between tube plates	11 ft. 4 ins.
Heating surface, tubes	1,131.4 sq. ft.
" " firebox	116.7 "
" " total	1,248.1 "
Grate area	17.0 "
Ratio of grate area to heating surface	1 to 73.6
Weight on leading (coupled) wheels	34,272 lbs.
" on driving wheels	37,856 "
" on trailing wheels	23,856 "
" total, in working order	95,984 "
Tender, diameter of wheels	3 ft. 9⅜ ins.
" wheel base	13 ft. 0 ins.
" capacity of tank	3,000 U. S. gallons
" weight in working order	67,424 lbs.

SOUTH AUSTRALIAN RAILWAYS.

The South Australian Railway Commissioners have issued their report for the year ending June 30, 1891. For the second time in three years the working of the railways was seriously prejudiced by the increased price of fuel, owing to labor troubles, and it is, therefore, considered desirable that a large stock of fuel should be maintained. In May, 1891, a contract was let to Martin & Co., of Gawler, a colonial firm, for 92 locomotives at $1,546,330, to be delivered in five years. Their previous contract was for 52 engines at $838,500, to be delivered in seven years from May, 1888. Up to the end of June, 1891, 6 broad gage and 10 narrow gage engines had been delivered, 7 have been delivered since, and 17 more are to be completed by June, 1892. The working of the South Australian railways for the year was attended with satisfactory financial results. The first line was opened in 1854.

A section 54½ miles long of the transcontinental line was opened in January, 1891. Its gage is 3 ft. 6 ins. This line being now practically completed to the point authorized by Parliament, it is desirable that the future policy in regard to it should be settled, and if the original intention of constructing the line as a new route through the continent, to open up its pastoral and mineral resources, is to be followed out, it is desirable that the rate of construction, the method of carrying out the work, and the method of providing the requisite funds should receive early attention. The total length of the line would be about 1,800 miles from Adelaide, of which about 700 miles at the southern and 146 miles at the northern end, have been built. There is already a transcontinental telegraph line. It is said that the railway has now crossed the worst of the poor country, and the reports show that from the present terminus the country improves. The total length of railways given in the report of Mr. A. B. Moncrieff, Engineer in Chief, is 1,812 miles of main track (10¼ miles being double track), and 181 miles of side track. Details of the track, with 80-lb. rails, were given in our issue of Oct. 31, 1891, and particulars of the operation of the railways in our issue of Feb. 7, 1891. The following particulars are taken from the report and are exclusive of 146 miles at the northern extremity of the transcontinental line.

Miles open at close of year, 5 ft. 3 ins.	1,161¾ miles
" " " " 3 ft. 6 ins.	504¼ "
" " " " total	1,666 "

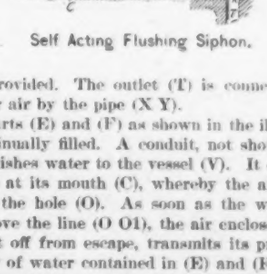
northern extremity of the transcontinental line.

Capital cost per mile	$34,210
Gross earnings	6,119,995
Working expenses	3,085,855
Net revenue	3,034,100
Percentage of working expenses to revenue	50.42
Passengers, ordinary and season tickets	5,295,991
Average journey per passenger	14.04 miles.
Average receipts per passenger per mile	1.74 cts.
Freight and stock carried	1,174,114 tons.
Average haul per ton	87.68 miles.
Average receipts per ton per mile	8.38 cts.
Train mileage	3,769,225 miles.
Total earnings per train mile	155.88 cts.
" working expenses per train mile	78.60 cts.
" earnings per mile open	$3,735
" working expenses per mile open	1,885
Locomotives	216
Cars, for passenger traffic	325
Cars, for freight and stock traffic	5,383
Population	320,000
Miles of railway per 1,000 population	5.2
Population per mile of railway	192

A SELF-ACTING SIPHON FLUSHING DEVICE.

The "Gesundheits-Ingenieur" describes an apparatus which may be used for emptying vessels or tanks automatically, or for flushing sewers, water-closets, etc., without any supervision being necessary.

The M-shaped pipe (D E F G) is attached to the vessel (V) as shown in the engraving; its mouth (C) is elevated but little above the bottom, while the other end empties into the outlet (T). The bottom of the vessel adjoining the latter is to be made tight in some convenient way, so that no water can escape into the outlet except by way of the pipe (D E F G). The parts (E) and (F) are provided with a bent tube (L I H). A valve (Z) between (F) and (G) furnishes the means of filling the apparatus at the start. Above the mouth of the part (D) an opening



Self Acting Flushing Siphon.

(O) is provided. The outlet (T) is connected with the outer air by the pipe (X Y).

The parts (E) and (F) as shown in the illustration are continually filled. A conduit, not shown in the cut, furnishes water to the vessel (V). It enters the part (D) at its mouth (C), whereby the air escapes through the hole (O). As soon as the water level rises above the line (O O1), the air enclosed in (D), thus cut off from escape, transmits its pressure to the body of water contained in (E) and (F), so that by continued rising of the water level in the outer vessel, water will start to flow from (F) into (G).

The vessel and M-shaped pipe are so proportioned that when the water rises near to the top of the former, the water in the part (D) ascends to line (M N), while in part (E) and the tube (L I H) it is forced down to line (P Q). By continued rising of the water level in the vessel (V), the air pressure upon the water contained in (E) increases, forcing it out of the part (I H).

By this action the air enclosed in (E) is liberated and the water in part of pipe (D), influenced by the pressure from the body of water outside, is forced over to (E), filling the knee between (D) and (E). At nearly the same time, the knee between (F) and

(G) will also be filled, as the outer body of water is above the level of the two upper knees. Thus a perfect siphon is established in the apparatus. The water will continue to flow through the M-shaped pipe into the outlet until the water level in the vessel (V) recedes to line (OO1), for as soon as the outer air enters the opening (O), the apparatus ceases to act as a siphon. The water contained in parts (E) and (F) remains, until its equilibrium is disturbed again by renewed rising of the water in the part (D), when it will again act in the way described.

The inventor of this apparatus is Federico Pescetto, Major of Engineers in the Italian army.

AN END-ADJUSTING GEAR FOR DRAW-BRIDGES.

By C. A. P. Turner and P. A. Warner.

The common form of draw span as built to-day, both for railway and highway purposes, is a continuous truss bridge with the center panel over the drum arranged so that little or no shear can be transmitted across it, by either leaving out the load covering one arm and entering the outer end of the other with the dead load considered as "swinging."

The dimensions for a 227-ft. draw span built last autumn for the Georgia & Alabama Construction Co. are shown in Fig. 1. Dead load 1,400 lbs. per lin. ft., and live load 4,000 lbs. for trusses, with two 104-ton engines on the floor. Cooper's specifications were used, all material wrought iron except eye-bars and pins, which are of steel. The sections were figured for the following conditions: Dead load swinging, with live load discontinuous; dead load swinging, with live load continuous, but without downward reactions at ends; and finally dead load and live load continuous.

By referring to the diagram it will be seen that the heaviest portions of this truss are over the drum, where the loading is supported not by the trussing, but by the drum itself—which, when considered with the uncertainty and variation in the strains to be provided for with any assumed loading, is not indicative of an economical arrangement.

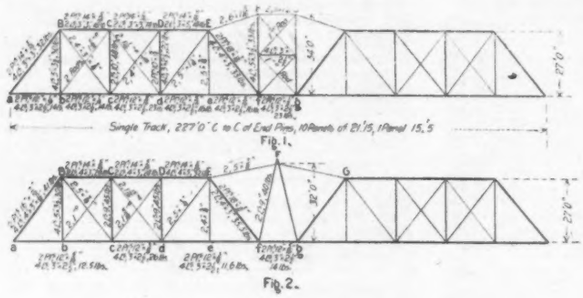


Fig. 1.

Fig. 2.

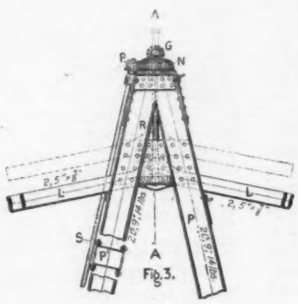


Fig. 3.

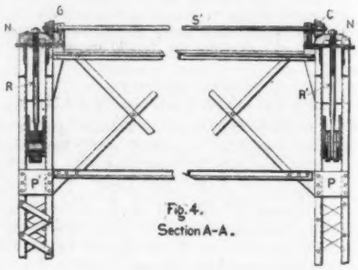


Fig. 4.
Section A-A.

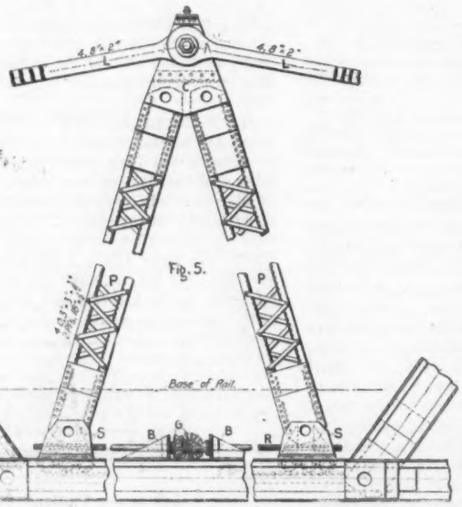


Fig. 5.

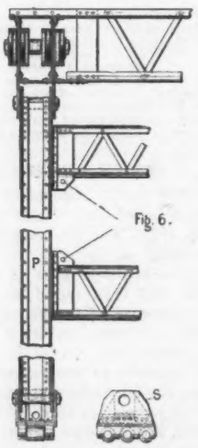


Fig. 6.

Fig. 8.
Tobble Raised.

Fig. 9.
Tobble Lowered.

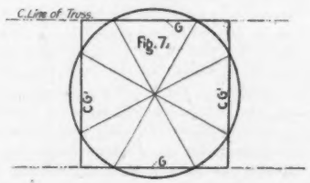


Fig. 7.

END ADJUSTING GEAR FOR DRAWERIDGES.

diagonals entirely or using only very light rods. The bridge being closed the ends are raised by screws or wedges, thereby diminishing the live "kick," and causing the truss to act more as a continuous structure for dead load. With the usual class of draw-tenders it is unsafe to depend upon the wedges being driven home and we are forced to consider the end reaction (the bridge being closed) as (A), equaling 0, and (B) the weight the wedges are calculated to raise—usually an amount sufficient to cause the trusses to act for dead load as continuous girders on level supports. The sections being then designed to withstand the strains of condition (A) or (B) combined with the live stresses.

The ends not being latched down, it is necessary to consider the following cases of loading: First. One arm covered by live load, which, as there is no shear transmitted across the drum, will produce strains in this arm as in a simple span. Now the live load covering one arm causes the other end to rise or "kick," giving the condition of dead load strains as "swinging." Second. The live load covering the whole bridge with the dead load considered as (A) swinging or (B) continuous. Third. The live

Suppose, now, by a detail to be described later, each arm is made to act as a simple independent span, see Fig. 2, the central members, E F, F G, Fg, Ff, and fg, being strained only when the bridge is open. Now, using the same loading and specifications we find the sections given in Fig. 2.

Comparing Figs. 1 and 2 the chords of the arm trusses will be seen to be somewhat heavier in the new design than in the old, while the webbing is lighter, as one familiar with the properties of a continuous bridge would suppose. The central portion is of course very much lighter. The weight of the arm trusses was found to differ but little in the two designs.

The weight of one truss, Fig. 1, was found to be about 52,660 lbs; Fig. 2, 48,350 lbs., a difference of 4,310 lbs. in favor of the new design, or a difference of over 8 per cent. of the material in truss.

Fig. 3 shows a side view of the detail for the hand operated draw of Fig. 2, by which it is proposed to force each arm of the draw to act as a simple independent span when the bridge is closed.

The chords Ff and Fg, Fig. 2, marked L in Fig. 3, form a toggle joint at the center which is raised and lowered by the system of screw eye-bolts and gearing shown, in which the shaft S runs nearly to the foot of P1, where it is turned by a hand crank (not shown) with miter gears. At its upper end S carries the pinion, which, engaging with the geared nut N, raises or lowers the screw eye-bolt R, and consequently the toggle on this side of the bridge. The geared nut N, through the gears G and shaft S1, revolves the nut N1, thereby simultaneously raising and lowering the toggle on the further side through the screw eye-bolt R1.

By raising the toggle centers as described the ends are raised and the draw may be swung open.

The eyes of the toggle chord bars are slotted so that after the ends are lowered to a bearing upon the abutments the toggle may be lowered still further, the pin working back in the slotted eyes as shown in Fig. 9.

This condition of the toggle entirely disconnects the two arms, forcing them to act as simple independent bridges.

Fig. 8 shows the toggle when raised. The inventors prefer to hinge the lower chord at f and g, though for the very small raise required it could probably be sprung without serious injury.

The geared nuts N and N1 are intended to be covered by a suitable cap not shown in the drawing. The ends of the toggle pins are flattened and move between vertical guide plates.

Fig. 5 shows the arrangement of toggle center preferred for a very heavy draw span operated by steam power. The sections of L and P are roughly figured for a 500-ft. double track span with arm truss 45 ft. deep. The lower ends of post P are fitted with roller shoes carrying a cast nut. The toggle center is raised by drawing the lower ends of the inclosed posts P nearer together by means of the screw rod R. The rod R is prevented from moving longitudinally by a collar and the brackets B. It is preferred with this to arrange the center girders, C G and G (Fig. 7), distributing the weight upon the drums as shown, the girders G supporting the chords carrying the track for the roller shoes S.

The mechanism of either of these arrangements of the toggle center is claimed to be cheap and simple, not likely to get out of order, and to save much

time in the drawing room, as there are no troublesome connections to arrange in the floor system for the rods or shafting by which the wedge or screw system is operated. The labor of computation is much reduced, but what is of more importance the strains can be determined with absolute certainty for any loading. The percentage of material saved varies little for spans longer than that figured, but increases slightly for shorter spans. The live "kick" is entirely avoided, and a good end bearing can be secured as for simple spans.

TESTS OF STRUCTURAL WROUGHT IRON AND STEEL.

One of the most interesting discussions on the important subject of testing which have taken place for some time was brought out by a paper read by Mr. Alfred E. Hunt, of the Pittsburg Testing Laboratory, at the Glen Summit meeting of the American Institute of Mining Engineers. Oral discussion at that meeting was followed by the contribution of several written discussions, and a final reply by Mr. Hunt, prepared since the recent meeting of the Association at Baltimore. We have postponed publication of this paper in order to present the complete discussion with it. The following is the substance of the paper as presented by Mr. Hunt:

Manufacturers of structural material frequently complain that in the tests prescribed, the number of tests required and the methods of making them and of interpreting their results, the engineers who draw the specifications do not sufficiently avail themselves of the experience of "the practical millmen," and are not themselves sufficiently acquainted by experience with the details of the work to frame intelligently their requirements for structural material. The inspector, under such contracts, often hears the engineers who drew the specifications characterized as "tyrannical," "impracticable," or "insatiable" and as clothed with unjust power over the business interests of the manufacturers.

Such incautious statements tend to lower the standard of integrity among subordinates who have direct charge of the work of manufacture, tests and shipments. These men sometimes get in this manner the notion that it is "smart" and for the interest of their employers and themselves to deceive the inspectors and to ship material that will not answer the specifications. It need not be argued that such a course will bring upon manufacturers, sooner or later, disaster in proportion to the failure of the structure, to which such defective material may have contributed.

On the other hand, by reason of the sharp competition and the difficulties of concerted action among manufacturers, there is often little scanning of the demands for test and their requirements until after the contracts have been closed; and then the engineer, upon being appealed to for modifications, often looks upon such efforts very properly as attempts to lower the actual quality, and probably the cost, of the material to be furnished, matters which he thinks should have been called to his attention before the acceptance of the contract but not after.

The following propositions are presented by the writer as either obvious or evident upon slight reflection:

1. The specifications for tests of structural material should furnish all necessary means for excluding all material deemed unsuitable by the engineer.

2. All testing costs money, which ought, either by special provision or by addition to the selling price, to be paid by the purchaser. In general, no doubt, this cost is practically added to (or, rather, included with other expenses in) the selling price by the manufacturer; consequently the number of tests and the severity of interpretation applied to their results should be limited by the engineer just as far as this can be done without sacrificing the first principle above stated. This he should do for the sake of that reasonable economy which he is in duty bound to secure for his clients.

3. Besides the direct increase of cost by unnecessary tests and too rigid requirements, there is another waste of money through waste of time. Material rejected must be replaced before work can be completed, or perhaps even commenced, at the shops where it is to be fabricated into finished structures. Such delays are often tedious and expensive, even when the rejections causing them are entirely justifiable. Often the consumer must wait the time when the proper rolls will again be in place for the same class of material; and rarely, if ever, do the terms of the contract secure to him adequate compensation for the losses, possibly very serious, thus occasioned through the vigilance of his own agent, the inspector. Of course, when excessive rejections and consequent delays are the result of unreasonable and perhaps ignorant or conceited severity on the part of the inspector, the mill-manager is tempted to regard with great complacency the consequent embarrassments of an engineer or boiler-maker or bridge-builder under a time forfeit.

The writer offers, from the standpoint of somewhat extended experience as an inspector of structural materials, some suggestions, directed to the following points:

1. What Tests are Usually Made to Determine the Quality of Structural Material?—Tensile tests, including the elastic limit and ultimate strength as measures of tenacity, together with the percentages of elongation and reduction of area as measures of ductility, are agreed upon by all as the best physical tests, all things considered, to determine the quality of structural wrought iron or steel. They are often necessarily expensive, owing to the cost of preparing test specimens from large sections. In the writer's judgment, cheaper tests can be advantageously substituted for a part only of the tensile tests, and have also the advantage of affording checks to errors that might continuously occur with one method of testing.

The determination of the modulus of elasticity in connection with tensile tests adds much to the time, labor and skill required, and is now seldom required as a measure of the quality of the metal. It is generally used only as a special test in determining the applicability of varying materials which are to be used together in the same members of a structure.

The other tests, commonly used in the best practice to-day are: (1) Annealed tensile tests of forged work, and of all material subject to subsequent annealing after test specimens have been taken. That is a series of tensile tests is required of specimens carefully annealed before being prepared for pulling in the testing machines; the results to be compared with those of tests made upon specimens in their original condition.

This seems to be an excellent provision, and the writer would suggest that for tension-bars of low steel at least, a suitable number of annealed test specimens should be pulled in tension to ascertain the normal tensile strength, since a considerably higher strength may be imparted to steel by cold-rolling, but will be lost in such a subsequent annealing as bridge-members receive after the eye-bars are made up. To determine the tensile strength which can be depended upon, therefore, the test-bars should be pulled annealed as well as unannealed.

(2) The drifting test, made by striking with a sledge upon a steel drifting pin in punched holes and noting the size to which these holes can be enlarged under different circumstances without fracture of the material, is a practical test that shows the actual behavior of the metal, and can be made upon scrap pieces without wasting merchantable stock and without expensive machine shop work upon the test specimens. A hole punched for a 3-4 in. rivet, its center being 1 1-2 ins. from the rolled or planed edge, is required to be capable of enlargement in this way without fracture of the metal until it will pass a rod of the diameter of 1 in. for wrought iron, 1 1-4 ins. for bridge steel and 1 1-2 ins. for boiler plate steel.

The writer believes this should be one of the standard tests of wrought iron and steel plate and shapes. It presents the further advantage that exact data can be obtained for records regarding it, and, when desired, specimens themselves can be kept conveniently, stamped with the melt-number and other identifying marks, as a record of the quality of the material.

(3) The bending test for soft structural steel is by itself not a crucial test quality. I have found many specimens that pulled in a testing machine very brittle and crystalline in fracture, yet under the bending test the bar would come over upon itself through an angle of 180 deg. without fracture. Most steel of less than 68,000 lbs. tensile strength and under ¾ in. thick will bend down double over itself, if the specimens have planed edges and sound specimens are taken to start with. At the same time, the bending test is properly regarded by engineers as one of the important corroborative tests for both wrought iron and steel.

(4) The nicked bending test for wrought iron is believed to be important, and, in all good inspection it is regularly made and carefully recorded as an evidence of quality. The conditions, however, under which nicked bending tests are made have much to do with the results. These conditions should be made as nearly as possible uniform, in order that their interpretation may be facilitated. The temperature at which the nicked bending fracture is made is an important factor. At low temperatures, as has been proved, most irons appear more crystalline than they do under ordinary summer temperatures. It need hardly be remarked here that the nicked bending test is not applicable to steel except under special conditions, as in rivets.

For rivet-rods, one of the best tests is actually to rivet up some work with them, then cut the rivets out and see that they cut tough and silky in the case of steel, or fibrous in the case of iron. Rivet-steel rods should not have over 60,000 lbs. per sq. in. tensile strength, and should forge successfully at a red heat.

Where steel scrap is used with iron, in wrought iron plates and shapes, the nicked bending test, nicking to various depths of the section before bending, is usually the best way of ascertaining the soundness of the welds, and may be recommended for frequent employment.

(5) The hardening or quenching test of low carbon structural steels prescribed by the Committee of the American Society of Mechanical Engineers (Eng. News, March 7, 1891) seems to the writer to be of doubtful utility, except when very carefully made and upon steels likely to be subjected to similar treatment in actual practice, such as firebox steel, some steel rivets, etc. In my experience, (Trans. Am. Inst., M. E., XII., pp. 315, 316.) all steel, no matter how low in carbon, will harden more or less, as shown by tension tests in a testing machine; the amount depending upon not only the "hardness" in the steel, but also the temperature to which it is heated and the character of the solution into which it is plunged to quench it. Unless all these conditions be very carefully kept uniform, the general experience is that conflicting results will be obtained from quenching tests.

In this connection it may be pointed out that the test prescribed in some specifications that steel having a tensile strength, in many cases, of from 64,000 to 70,000 lbs. per sq. in., and in some cases of from 60,000 to 68,000 lbs., shall be capable in test specimens of bending double on itself after being heated to "an intense heat," or to a "cherry red heat," and then plunged into water, is very unsatisfactory, because the temperature to which the specimen has to be heated is difficult to determine and yet small differences in this temperature have much to do with the endurance of the steel under the test.

(6) The bulging test recommended by Kirkaldy, though not often used in this country, is a useful practical measure of the ductility of the metal, and is especially adaptable for testing soft flange steel. A sheet somewhat larger than the diameter of the dies being pressed through them, the energy actually expended and the amount of bulging of the plate through the dies under the given pressure give an excellent measure of the metal's ductility. The pressure upon the dies being exerted by the moving plate or plunger of an ordinary testing machine, its amount can be measured. This is a very easy, quick, and not at all expensive test, and the actual specimens may be preserved as a valuable record of the facts.

(7) Compression tests are not usually called for as methods of determining the quality of wrought iron or steel. Since the factor of the ductility does not largely or primarily enter into such tests as commonly performed, they are by no means conclusive as to quality. Metal like cast iron, for instance, will give better results under compression than good soft steel.

(8) Cold forging tests have been included in some specifications which have required that a bar 1-2 in. sq. be capable of being forged down cold to a thin flat edge. Much depends upon the skill of the smith who does the work; and as there are easy ways of evading the requirements of the specification, the test is seldom used, and the writer believes it is of doubtful utility.

(9) Hot forging tests of metal to be used for special purposes, and as direct practical trials of the fitness of the metal for the work required of it, are often employed, and seldom objected to.

(10) The welding test is another practical test of wrought iron, generally confessed to be reasonable where the metal is destined to be welded in actual use.

(11) Specific gravity determinations, says Kirkaldy, in his new work on testing, furnish an accurate method of determining the relative qualities of structural material. The writer's experience has not been very large in this matter, as the specific gravity test is not an ordinary one for structural steel and iron; but from that experience he believes that in order to compare and generalize upon such determinations, the observer must have made them upon specimens treated under exactly similar conditions. This condition being fulfilled, specific gravity determinations, being relatively inexpensive and quickly made with the proper apparatus, may be found excellent tests of structural material. The subject certainly deserves further consideration.

(12) Specifications for most kinds of structural iron and steel which require, in addition to tensile and other physical tests, full chemical analyses of the metal, showing a given chemical constitution within very narrow limits of variation, are manifestly too severe for reasonable economy, except in special cases, where the importance of securing a metal exactly like previous standards overbalances any question of the considerably increased expense involved. Steel for the machinery

of locomotives and other rolling stock is an instance in point.

Inevitable variations in the raw material, the process of manufacture, and the amount and methods of manipulation from the pile, bloom, or ingot to the finished material, preclude the certainty of obtaining always the same tensile strength from the same chemical analysis. For example, to secure a given tensile strength a considerably higher percentage of carbon is required in the very low phosphorus boiler plate and other structural steel made by the basic process to-day, than in similar metal made by the acid process. The same thing is true of open hearth steel largely made from soft direct made bloom iron, such as the product of the Carbon Iron Co., of Pittsburg, or from soft puddled blooms as compared with the metal made from hard steel scrap stock. Except where the larger deflection under transverse loads becomes a serious factor, the softer steel is better, and I believe it can be safely trusted under higher unit strains than the metal with a greater strength and greater apparent factor of safety. In this particular the common engineering practice and reasoning seem to me erroneous, especially where the metal is to be heated and forged locally, as in eye bars, or where it is to be subject to alternate heating and perhaps sudden cooling, as in firebox steel. In such cases, steel below 64,000 lbs. per square inch in tensile strength can be safely trusted, in the writer's judgment, with a higher unit strain than metal of higher ultimate strength obtained by running the carbon over 0.18 per cent.

As outlined above, there are reasons which may justify, under some circumstances, where high ultimate strength is required, the prescription of a carbon test with a maximum allowable limit. It should be said, also, that very soft steel, as ordinarily made by the open-hearth or the Bessemer processes, becomes seamy, open, and unsound if below .07 per cent. in carbon. Again, in some cases, where the metal will be subjected to a considerable forging, a sulphur requirement, with a maximum of .04 per cent. for steel and .05 per cent. for wrought iron, is advisable. But under ordinary conditions this matter, as well as that of the other chemical constituents, with the exception of the phosphorus in steels, can be safely and most wisely left to the manufacturer's own judgment. With regard to phosphorus, however, there is strong reason for specifying and limiting it in structural steel, for it has been found that more than 0.10 per cent. of this element greatly increases the chances of failure under the physical tests, while steel containing less than 0.08 per cent. of phosphorus gives much more uniform results physically than higher phosphorus metal. Since the percentage of phosphorus in the stock from which acid steel is made determines largely (in inverse proportion) its relative cost, the manufacturer is tempted to let the phosphorus run near the danger line, and often this economy is carried to a point that involves a positive loss, by reason of the increased amount of rejections thus occasioned. In order to put all parties upon an equal basis in bidding, as well as to secure a safeguard against cold-short metal, a maximum phosphorus limit is now almost universally made for steel, 0.10 per cent. being the more lenient, 0.08 per cent. the more rigid requirement for acid steel. For basic steel, it has been considered wise to determine the phosphorus in each melt in order to know that the basic slag has performed its function properly. Many engineers demand less than 0.05 per cent. in basic steel where they allow .08 per cent. in acid steel of less than 68,000 lbs. per square inch tensile strength. This extra requirement is based upon the supposition that unless very high phosphorus ferro-manganese be added or there be some improper treatment in the last stage of the heat which restores a portion of the phosphorus to the metal, phosphorus ought to fall below .05 per cent. in properly made basic open-hearth or Bessemer steel of less than 0.20 per cent. carbon.

A considerable number of specifications made within the past few years for bridge steel have discriminated against Bessemer steel, engineers preferring to pay the larger price for the greater average uniformity of open-hearth metal. Many specifications give a preference to open-hearth steel by fixing the phosphorus limit at .08 per cent for acid open-hearth and .05 per cent. for basic open hearth and for Bessemer, whether acid or basic. This as explained above, is not, however, a stipulation against basic open-hearth steel, for it has been found that no rejections are occasioned by the .05 per cent limit for such metal.

A phosphorus limit in wrought iron has been sometimes called for; but it is only when the amount actually existing in the metal as a phosphide is separated from the phosphorus existing as a phosphate in the contained slag of the wrought iron that any intelligent discrimination can be based upon the phosphorus test. In the writer's opinion, it is not required as a means of distinguishing good structural wrought iron from bad, and is not to be recommended. In most cases where it is found in a specification, the author has probably reasoned by analogy that because the phosphorus requirement is wise for steel, it should be applied to wrought iron. This reasoning fails to recognise the chemical difficulty of accurate determinations, and ignores the practical sufficiency of the nicked bending tests for indicating cold shortness in wrought iron.

(To be continued.)

A valuable railway library, with funds to make it the most complete in existence, has been presented by Mr. Timothy Hopkins, ex-Treasurer of the Southern Pacific Ry., to the Stanford University. The collection includes a complete set of all railway commission reports in this country and England, and is particularly rich in early pamphlets. The donor's instructions are that every work about railways, which has been published in any language, shall be bought and added to the collection. The collection, as it now is, covers about 1,000 books and an equal number of pamphlets, but it is expected to at least quadruple these numbers.

A new style of steam motor is to be tried on the West Chicago Street Ry. Instead of an ordinary boiler the machine is said to have a receiver, charged with water heated to a high temperature. This receiver is jacketed to prevent radiation, while a simple form of auxiliary heat, occupying but a small space, assists in maintaining a steam producing standard of heat in the water for five to eight hours from one charging. Steam is generated as needed from this heated water, and, passing into the cylinders, performs its work as in the locomotive. The motor is charged from a stationary boiler, the process occupying about two minutes. A run of 20 miles can be made without recharging. The weight of the car and apparatus is nine tons, the car seating about 30 passengers. The machine is owned by the Kinetic Power Co., of Chicago.

Breadstuff exports for the nine months ending with March have had the enormous value of $233,159,912, against only $85,252,926 the year before. For the month of March they were about twice only what they were a year ago. From 10 to 15 per cent. of this valuation is shipped from the Pacific coast.

A heavy suburban compound engine for the Philadelphia & Reading R. R. has been built by the Baldwin Locomotive Works, Philadelphia, Pa. The engine is on the Vauclain four-cylinder compound system (Eng. News Feb. 20, 1892.) It has six driving wheels, a leading two-wheel pony truck and a six-wheel trailing truck under the cab and tank. It is intended to burn anthracite fuel and the grate is composed of water tubes. There is no extension front to the smokebox. The engine was designed by Mr. L. B. Paxson, Superintendent of Motive Power of the Philadelphia & Reading R. R., and is to be tried with different kinds of fuel on the Chicago suburban lines of the Illinois Central R. R., with a view to the adoption of this type of engine for suburban traffic. The use of a cheap grade anthracite fuel, for which the firebox is designed, combined with the soft blast due to the compound system is expected to reduce the smoke nuisance to a minimum. The leading dimensions and particulars are as follows:

Cylinders, h. p.	12x24 ins.
Cylinders, l. p.	20x24 ins.
Diameter of driving wheels	5 ft. 1 5-8 ins.
" of truck wheels	2 ft. 5 3-4 ins.
" of boiler barrel	5 ft. 0 ins.
Firebox, type	Wootten
Firebox, size	9 ft. 6 ins. x 6 ft. 8 ins.
Length of combustion chamber	3 ft. 0 ins.
Boiler pressure	175 lbs.
Tubes, number	321
" diameter	1 1-2 ins.
" length	9 ft. 0 ins.
Total wheel base	35 ft. 0 ins.
Weight on driving wheels	91,000 lbs.
Weight, total	158,000 lbs.
Capacity of tank	2,000 gallons

Two new sewerage schemes are proposed for Albany, N. Y. One is for a high level intercepting sewer emptying into the river at the lower end of the city, and away from the city water supply. The estimated cost is $1,200,000. The other plan is for a low-level intercepting sewer along the river front, emptying at about the same place as the other, and to cost $500,000. The proposed filling of the Albany basin would necessitate the immediate construction of one of these sewers; or an abandonment of the present source of water supply, says the Albany press.

An action was brought some time ago by the Johnson Railroad Signal Co. against the Union Switch & Signal Co. to determine which company was the legal owner of what are commonly known as the Sykes block signal patents, issued in this country to Frederick Cheesewright. We are informed that Judge Atcheson, U. S. Circuit Judge and Chief Judge of the U. S. Circuit Court of Appeals of Pennsylvania, has recently filed his opinion, holding that the Union Switch & Signal Co. never obtained, and has not now any title to these patents, but that they are the property of the Johnson Railroad Signal Co. Whether this ends the litigation, or how completely the patents in question cover the important elements of the Sykes system, we do not know.

A Department of Buildings, headed by a Superintendent of Buildings at $5,000 per year, is created for New York city by a bill just passed at Albany. This department has jurisdiction in all that relates to lighting, plumbing and drainage, and assumes duties now divided between the fire department, Board of Health and Bureau of Inspection of Buildings.

Experiments with lubricants have been made on the Indian railways, and the "Indian Engineer" states that as a result the use of castor oil will be discontinued. Except in the case of one or two railways, Canadian mineral oil has been found a cheap and efficient substitute. In view of the large consumption of oil on Indian railways, amounting to many thousand tons per annum, the change is likely to have a very serious effect on the castor oil industry.

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF MARCH, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.) Average	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average	Max.	Direction at time of max. velocity.	Precipitation—(Rain and melted snow)—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	23	46	— 4	50	9.9	40	W	1.13	0.46	11
	Portland, Me.	30	51	9	42	10.9	38	N	2.27	0.59	9
	New York City	35	56	16	40	14.6	40	SW	4.32	1.37	9
	Pittsburg, Pa.	35	61	13	48	6.6	28	NW	2.29	0.46	15
	Chicago, Ill.	31	53	5	48	19.2	57	SW	2.21	0.59	14
	Omaha, Neb.	24	73	7	66	10.2	42	NW	2.74	1.07	11
	St. Paul, Minn.	23	56	— 2	58	6.1	48	W	0.75	0.42	8
	Duluth, Minn.	24	52	— 6	58	7.7	60	NE	2.02	1.25	6
	Bismarck, N. Dak.	26	60	—10	70	9.2	72	NW	0.95	0.56	7
	Average	29.6	56.4	3.1	53.3	10.5	47.2	.....	2.11	0.95	10
Southern Cities.	Washington City	38	66	17	49	9.3	44	NW	5.70	1.06	16
	Louisville, Ky.	42	76	14	62	9.7	40	W	3.23	1.04	15
	St. Louis, Mo.	40	78	14	64	12.8	46	NW	1.92	0.51	12
	Savannah, Ga.	56	83	27	56	8.4	27	NW	4.12	3.06	7
	Leavenworth, Kan.	38	78	12	66	11.6	52	NW	4.09	1.22	14
	Jacksonville, Fla.	60	84	29	55	7.2	33	SW	0.76	0.27	5
	Chattanooga, Tenn.	48	81	20	61	6.7	30	NW	3.35	1.03	13
	New Orleans, La.	59	78	31	47	9.5	40	SE	2.82	1.13	8
	Memphis, Tenn.	48	81	18	63	8.6	42	SW	4.05	1.29	9
	Palestine, Tex.	54	84	22	62	8.1	27	NW	4.70	1.70	7
	Average	48.3	78.9	20.4	58.5	9.2	38.1	.....	3.47	1.29	11
Western Cities.	Helena, Mont.	36	65	8	57	8.6	58	SW	0.31	0.18	6
	Port Angeles, Wash.	44	57	30	27	4.9	30	W	1.62	0.39	14
	San Francisco, Cal.	54	80	42	38	7.3	36	S	2.85	0.90	11
	Salt Lake City, Utah	43	68	26	42	6.6	36	SW	2.21	0.69	13
	Denver, Colo.	36	74	6	80	8.3	36	NW	1.30	0.64	10
	Yuma, Ariz.	65	92	40	52	8.1	43	NW	0.52	0.44	2
	Santa Fé, N. Mex.	39	60	15	45	9.2	48	SW	1.51	0.58	10
	Average	45.3	70.9	22.1	48.7	7.6	41.0	.....	1.46	0.53	9

The Memphis bridge, over the Mississippi River, was crossed for the first time on April 5. There was still at that date a gap of 60 ft. at the eastern end. But a 14x14-in. stringer was put down, and a party of venturesome men walked over it. It is hardly necessary to say that they were men trained to the business.

Petroleum exports for the nine months ending with March are about the same in quantity as a year ago, 530,308,000 gallons, but decidedly lower in price. The average price per gallon for the nine months, of crude and refined petroleum, we compute as follows:

	1892	1891
Crude petroleum, cents per gallon	5.1	6.5
Illuminating oil (76 p. c. of the crude)	6.9	7.9
Naphthas (12 p. c. of the crude)	7.2	8.2
Lubricating and paraffin oils (3 p. c.)	15.2	14.2
Residuum (about 9 p. c.)	8.6	4.7

It will be seen that the heavier products are tending to rise in price; the others to fall, in sympathy with the price of crude petroleum. The fall in the latter may be a mere temporary fluctuation, or may be an effect of European competition.

Shipping coal by a pipe line is the novel project in which Mr. Wallace C. Andrews, of the New York Steam Co., is now interested. He proposes to pulverize the coal at the mines, wash it, and remove all the slate, sulphur, etc. Then it is to be mixed with water and, under 1,200 lbs. per square inch pressure, forced through pipes to its destination. At the delivering point it is caught in great tanks, dried and pressed into bricks for fuel. Mr. Andrews has been experimenting and says he can send this fine coal and water at a speed of 5 miles per hour to any distance. In 24 hours a 4-in. pipe, at the above rate and pressure, he says, will deliver over 300 tons of coal per day; a 12-in. pipe, 5,000 tons, and a 24-in. pipe, 28,000 tons.

The tests of cellulose lately made at Norfolk, by the Navy Department, with the view of excluding water from shot holes, had the following results: The cellulose, obtained from cocoanut fiber, was mixed in the proportion of 14 parts of the granular cellulose to one part of the fiber. Two iron caissons were packed by the aid of jacks, one with 808 lbs. of the compressed cellulose, the other with 32 bags holding 25 lbs. each of the cellulose. Two shots were fired into each with a 6-in. rifle, with a striking velocity of 1,525 ft. per second. When these caissons were tested with water, the one packed with bags failed entirely to close the shot holes by swelling, or to exclude water. The one with loose cellulose tested somewhat better. At the beginning of the test the water flowed through at the rate of 2.7 gallons per minute; this was reduced to 0.9 gallons per minute at the end of four hours. The Board reports that the cellulose used in cofferdams of warships should be packed loose and compressed by jackscrews or other like appliances, not hand rammed, and the cellulose must be thoroughly mixed in proper proportion of granular and fiber. In this mixed state it burns very slowly, but there is no flame.

The National Railway Exposition, incorporated, has opened a permanent exhibit of railway, electrical and mechanical appliances and inventions at Nos. 22 and 24 Custom House Place, Chicago. The purpose of the corporation is to rent space to manufacturers, at $6 per sq. ft. per year, and make their quarters sufficiently useful and attractive to induce railway men and officials to visit their rooms when making independent investigations of the different appliances. E. H. B. Twining is President, N. C. Miller, Secretary.

German railway men, says the "Pall Mall Gazette," are paid about as follows on the state lines: Presidents, $2,500 per annum; telegraph inspectors, $750 to $1,000; bookkeepers and secretaries, $500 to $800; ticket-office clerks, $250 to $375; and ticket gatherers or guards, $200 to $300. The engine driver is paid $300 to $500 per year; his helpers from $5 to $7 per week, and guards on trains, $200 to $300 per year.

Steel burglar and bullet proof express cars are being built at the Milwaukee shops of the Chicago, Milwaukee & St. Louis Ry. for the use of the American Express Co. They will be 50 ft. long by 8 ft. wide, with an inside steel room for valuable express matter, and, inside of that again, a strong safe, built into the car.

An electric railway, now commenced, and to connect Singapore with Johore, Farther India, marks the march of modern transit methods around the world.

The action upon aluminum of various acids incidental to the preparation of food has been dilated upon by certain German professors. Prof. Lange now shows that these experiments were made with aluminum foil and the results noted are not apparent when the compact sheet metal is employed, as it would be in practice. With six days' exposure, he finds scarcely appreciable action upon the aluminum from the following liquids: Red and white wine, orandy, 50 per cent. alcohol, 1 and 5 per cent. solutions of tartaric, acetic, citric, and carbolic acids, 3 per cent. butyric acid, 5 per cent. lactic acid, 4 per cent. boric acid, 1 in 400 of salicylic acid, coffee, tea, beer, etc.

The aqueduct tunnel under the Mersey River, for the Liverpool water-works, is 805 ft. long and 10 ft. in diameter. It was started in 1888, and, after two contractors had failed upon it, it was taken in hand by the Liverpool Corporation in October, 1891, by the advice of Chief Engineer George F. Deacon, only 182 ft. having been driven to that date. On Nov. 12 work was commenced, and notwithstanding a defective driving shield, and various stoppages, due to the difficult strata penetrated, the remaining 623 ft. has been tunneled at an average rate of 34 ft. per week. The greatest distance driven in one week was 57 ft. The tunnel has been all lined with cast iron 1 11-16 in. thick, in segments 18 by 20 ins. The 32-in. riveted steel pipes have yet to be laid in the tunnel, supported on greenheart timbers. But it is expected that the full Vyrnwy water supply will be turned on to Liverpool this summer. The actual cost, though not given, is said to be much below the estimate.

Electric railways will soon be established on the principal streets in Brooklyn, N. Y. The Atlantic Ave. Ry. Co. has given a contract to the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa., for the equipment of 100 cars, including 200 motors of 30 HP., and four generators of 250 to 780 HP., aggregating 2,000 HP. About 100 motors are to be delivered in June and the remainder in December, and the entire plant is to be completed before the end of the year. The Brooklyn City Ry. Co. has let contracts as follows: For equipping 250 cars with two 25 HP. motors each, to the Thomson-Houston Co., of Boston, Mass.; for trolley, return and feed wires, to the Ansonia Brass & Copper Co., of Ansonia, Conn., and the Simplex Electrical Co., of Boston.; for tubular poles 27 ft. long in 6, 5 and 4 in. sections, to W. H. Wallace & Co., New York; for one mile of track with 66-lb. girder rails to the Johnson Co., of Johnstown, Pa., and for nine miles of 65-lb. box-rail, to the Lewis & Fowler Co., of Brooklyn, N. Y. The poles are to be provided with four pin cross arms for supporting feed wires, and eyebolt for the guard wire span. The span wires are to be mostly of Norway iron, but as an experiment a portion of the line will be equipped with bronze wire. The rail joints will be bonded in the ordinary manner, and the return wire will consist of heavy tinned copper wire. The girder rails will have the Johnson standard rail joint, and the chairs will be electrically welded to the rail.

Dusty roadbeds in India, on parts of the lines where sand is used for ballast, are being improved by covering the ballast with 3 ins. of broken stone, which is found to be more effective than screened gravel. This prevents washing and blowing away of the ballast, causes less dust, and, therefore, less wear of the journals of rolling stock.

A Missouri River dam, at Stubb's Ferry, 12 miles above Helena, is proposed by capitalists of the latter place. The dam would be 30 ft. high above the present water level. The object is to establish water power.

The Benevolent Fund of the Institution of Civil Engineers last year expended the large sum of $16,400 in assistance to needy members, receiving some $16,600, about equally divided between annual subscriptions of 768 subscribers, and dividends on about $186,000 of capital. The fund is administered with the most admirable and cautious respect for the feelings of those needing assistance, yet with extreme care to avoid waste of funds on the undeserving. The principles followed in the distribution of the fund are thus explained in the last report of this splendid charity:

"The principles which regulated the action of their predecessors, in dealing with applications for assistance, have been strictly followed by the committee of management now retiring, namely, on no occasion to lend money, or to advance money for the payment of debts, because in both cases creditors would be in the main benefited, and not the applicant, who might under such circumstances be induced, and be allowed, to become more and more pecuniarily involved. As the committee understands its duty, the fund is intended to relieve, or to assist on a moderate scale, members, who, from advanced age or ill-health, are unable any longer to obtain remunerative employment; to help widows and orphans left unprovided for; and especially to furnish means, in part at any rate, for the education of children, in the hope that they may later on earn their own living."

A new United States Patent Office, the entire cost not to exceed $3,500,000, is provided for by a bill now before Congress. The Secretary of the Interior, the Commissioner of Patents and Chief of Engineers Casey are to form a commission to select a site.

An electric slot railway, with the current carried underground, has just been tested and found to work satisfactorily in Chicago. The line consists of a loop running through Fullerton, Racine and Webster Aves. and Halstead St. Since the test it has been accepted and is to be used as a feeder to the main line of the "Yerkes's" system on the north side. In general appearance, the line resembles the ordinary cable road, there being a slot in the center of the track, and the usual cast iron yoke. The wires are attached to the upper side of the yoke, one on each side of the slot, and over these a two-wheel trolley passes, having a spring attached to each wheel to accommodate the trolley to the lateral motion and to go round curves. Electricity is furnished from a central station. This line was put in by the Love Electric Traction Co., of Chicago.

A penny in the slot postal call box has been established near Charing Cross Station, London, for the collection of letters to be forwarded by the Post Office express service. It is in electrical connection with the postal telegraph office, opposite the station. By dropping a penny into the slot, and pulling out the slide, a brown-colored envelope is delivered containing another envelope and a card. The communication is intended to be written on a card, which is then inclosed in the white envelope, and this, with the fees for delivery, which have been fixed at 6 cts. per mile, is re-inclosed in the outer envelope, and deposited in the box behind the flap, which bears the printed instructions. The act of withdrawing the slide sends the call signal to the telegraph office, and a messenger is at once dispatched to collect the special letters.

The World's Columbian Exposition Co. has elected the following officers for the ensuing year: Pres., W. T. Baker; Vice-Pres., H. N. Higginbotham; Commissioner-at-Large, T. B. Bryan; Treas., A. F. Seeberger; Auditor, W. K. Ackerman; Attorney, W. K. Carlisle; Secy. H. O. Edmonds.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

CLEVELAND, LORAINE & WHEELING.—This company will soon let contracts for replacing the long trestle near Flushing, O., with a 15-span plate girder viaduct. The viaduct will consist of 13 spans 32 ft. long and two spans 62 ft. long.

ADIRONDACK & ST. LAWRENCE.—A press dispatch says: "Construction work on the Adirondack & St. Lawrence R. R. is being vigorously pushed forward, the mild weather being of great advantage. Workmen are now laying track in sight of White Lake, 17 miles north of Remsen. It is understood that the men will shortly move their quarters from Remsen to camps near Big Woodhull, which are now being fitted up for that purpose. Another engine for construction work will be sent to Remsen the latter part of the week to assist in the work. As the distance from Remsen to the scene of active operations is increasing every day, it will keep one engine occupied continually in hauling material. The Elmira Bridge Co., of Elmira, N. Y., has erected a tool house at Remsen, having secured the contract for putting in nearly all the iron bridges on the line. Fairbanks, Morse & Co., of Chicago, have the contract for putting up the water tanks along the line, and have just completed one at Remsen, with a capacity of 50,000 gallons. From Poland north, the construction train has crossed the bridge at Gravesville, and will soon be at Trenton Falls, when the iron bridge now in waiting at Herkimer will be at once put in position, and the construction work continued to Remsen and Hinckley. From Malone south the construction train is at work laying rails 14 miles south from Tupper Lake. This construction train and one from Remsen going north to meet it, are 60 miles apart. The grading between these two points is nearing completion, and the two parties expect to meet in two months. Many miles of the 60 are now covered with ties, being supplied by lumbermen along the route, at 35 cts. each."

ALTOONA, CLEARFIELD & NORTHERN.—At a recent meeting of the directors of this company it was decided to begin work on the proposed extension to Coalport, Pa., at once. The grading will be done for standard gage, but it is the intention to lay a narrow gage track.

PENNSYLVANIA.—Surveys are in progress for a railway from Lyon's Run, on the Turtle Creek Valley R. R., to Harrison City and Manor Valley, to open up coal lands owned by the Westmoreland Coal Co.

DELAWARE, LACKAWANNA & WESTERN.—Surveys are being made for the proposed Rochester, Honeoye & Bloods R. R., by which this company proposes to enter Rochester, N. Y.

Projects and Surveys.

DAYTON, LEBANON & CINCINNATI.—The surveys for this line from Dayton, O., via Centerville, to Lebanon, O., 25 miles. The maximum grade will be 1%, and the maximum curve will be 4 degrees. Contracts will probably be let about May 1. Pres., Stephen J. Patterson; Ch. Engr., H. E. Talbot; both of Dayton, O.

DETROIT TRANSIT R. R. CO.—This company has been chartered in Michigan to build a double track elevated railway around the city of Detroit. The total length of the line will be about 30 miles, and its object is to furnish a transfer line for the several railways entering the city, and also a general means of rapid transit. Chas. H. Ellis, of Detroit, Mich., is at the head of the enterprise.

MARYLAND & WASHINGTON.—The bill chartering this company to build a railway from Laurel, Md., to Washington, D. C., has been signed by the Governor.

NEW YORK & BOSTON INLAND.—This company will soon apply for a charter in Connecticut. Its object is to incorporate under Connecticut laws, for the benefit of the Boston & New York Rapid Transit Co. The directors are F. H. Alfred, D. L. Briggs, E. H. White and S. H. Warner.

READING, LANCASTER & BALTIMORE.—Surveys have been commenced for this proposed railway from Reading, Pa., to Lancaster, Md. S. C. Slaymaker, Lancaster, Pa., Ch. Engr.

Southern.—Existing Roads.

GULF & SHIP ISLAND.—It is rumored that a German syndicate has secured this road, and will complete it from Gulfport, Miss., to Jackson, Tenn., as projected.

ATLANTIC COAST LINE. About ten miles of track have been laid on the 20-mile branch to Washington, N. C.

PADUCAH, TENNESSEE & ALABAMA.—It is stated that surveys will soon begin for the proposed extension from Hallow Rock, Tenn., to a connection with the Tennessee Midland R. R.

HARRIMAN COAL & IRON.—This company has contracted for 1,500 tons of 56-lb. steel rail, to be used on the line from Harriman to Brushy Mt., Tenn., 14 miles. J. P. Suverkrop, Harriman, Tenn., Ch. Engr.

TENNESSEE & COOSA.—Contractors A. N. Nichols & Co., have begun work on the 3½-mile extension to Guntersville, Ala.

NORFOLK & WESTERN.—This company will build a branch to the Massanutton Mt., Va., about 3 miles long.

PICKENS.—The contract for building the line from Easley to Pickens, S. C., 9 miles, has been let to J. H. Burkhalter, of Augusta, Ga. Pres., Julius E. Bog, Pickens, S. C.

Projects and Surveys.

MEADOW CREEK.—A correspondent writes that the preliminary surveys for this railway have been completed, and that construction will begin in a few days. The road is to be completed by Aug. 1. It is a private enterprise, and its object is to develop the new coal fields of the New River coal region. Two new mines will be opened up at once in addition to the seven now in operation. The company owns 15,000 acres of mineral land in Fayette Co., and adjoining counties. The route of the road is through a mountainous country, and the work will be quite heavy; maximum grade 2½%, and maximum curve 12 degrees. Pres., J. L. Beury, Beury, W. Va.; Ch. Engr., E. S. Hackett, Colt, W. Va.

BARTOW & PLANET CITY.—Ch. Engr. Jas. L. Johnson, Barstow, Fla., writes us that this railway is projected to run from Bartow to Plant City, Fla., 19¼ miles. The preliminary surveys have been completed and location will begin about April 25. All of the right of way has been secured, and considerable local aid obtained. Contracts will be let as soon as the location is completed and the line pushed rapidly to completion. The company was chartered March 15, 1892. J. H. Saturn, Pres.

LOCKHART SHOALS.—Surveys for this railway, from Jonesville to Lockhart Shoals, S. C., have been commenced at Jonesville. Peake & Perrin are the Engineers.

HINTON & NEW RIVER.—A correspondent writes us that the surveys will probably soon begin for this West Virginia railway. Pres., J. H. Miller, Hinton, W. Va.

FRENCH CREEK & LITTLE KANAWHA.—Chartered in West Virginia to build a railway from Hampton, Upshur Co., to Arnold Springs, Lewis Co., W. Va. The Principal offices will be at Buckhannon, W. Va. J. A. Newton, Buckhannon, W. Va., is one of the incorporators.

LEXINGTON & WESTERN.—The stockholders of this company, recently chartered in Virginia, held a meeting April 15 to complete its organization.

GULF PORT.—Chartered in Alabama to build a railway from Mobile Point, near Ft. Morgan, Baldwin Co., Ala., to Citronville, on the Mobile & Ohio R. R., in Mobile Co., Ala. Among the incorporators are: Allen Cox, Philadelphia, Pa. and Joshua M. Dawson, Cincinnati, O.

TENNESSEE CENTRAL.—A press dispatch says: "The latest advices indicate that the Tennessee Central R. R. will be built at an early day. This company was chartered in 1872, and bonds were voted from all the towns on the proposed line. Fourteen miles of the roadbed were completed in 1873. Two years ago the same company again began to work, and the roadbed was completed from Trenton to McLemoresville, 30 miles. For lack of funds work was again stopped. The present company is backed by capitalists in New York city. The line is surveyed from Florence, Ala., to the Mississippi River."

Northwest.—Existing Roads.

DULUTH, MESABA & NORTHERN.—About 500 men are now at work on this line from the Artichoke River, north. All of the right of way, except a few miles has been cleared, and work is being rapidly pushed.

Projects and Surveys.

BAYFIELD, LAKE SHORE & WESTERN.—Pres., R. D. Pike, Bayfield, Wis., writes us that this railway is projected to run from Bayfield, Wis., to Iron River, Wis., at the junction of the Northern Pacific R. R. and the Duluth, South Shore & Atlantic R. R., a distance of about 100 miles, of which 45 miles have been surveyed. Surveys will be resumed about May 1. The route is through a fine pine and hardwood timber region, and its principal business will be timber and timber products. Work securing the right of way will begin about May 1, and contracts will be let about the same time. It is hoped to have the line completed by Oct. 1. The company was chartered Feb. 20, 1892. W. W. Downes is Secretary. The Chief Engineer is to be employed soon.

Southwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—About 3,000 men are now at work on the extension of this railway north, through Indian Territory. About 15 miles of track have been laid from Minco, I. T. south, and it is expected to have the line completed to the Red River by Aug. 1.

Projects and Surveys.

AUSTIN & SUBURBAN.—A railway company by this name has been chartered in Texas. Among the incorporators are J. M. Hoyte, New York City; George P. Warner, Dallas, Tex., and S. Haulenbeck, of Chicago, Ill.

SPRINGFIELD, SEDALIA, MARSHALL & NORTHERN.—A press dispatch from Sedalia, Mo., says, "Work will soon begin on the Springfield, Sedalia, Marshall & Northern Railway, the road that is to run from Springfield, Mo., through the city to Miami on the north. The survey was completed last autumn. O. A. Crandall, of this city, one of the directors, and Henry Strother of Saline Co., also a director, have just returned from a trip north and south over the proposed route. They report everything in the most flattering condition for the progress of the work and fine weather is only awaited to get it under way. The road will make a direct outlet from Chicago to the Gulf, and such is the final object."

Rocky Mt. and Pacific.—Existing Roads.

BURLINGTON & MISSOURI RIVER.—The Helena, Mont., "Independent" says: "A surveying party in the employ of the Burlington & Missouri River R. R. has been at work for some time past near Billings, Mont., surveying for the proposed route of the extension of the road from the Back Hills. The party is surveying through Billings and across Yellowstone River, north and south. The road has already reached Powder River in Wyoming, and the contract has been let for 250 miles additional of the extension, which will bring it to the Yellowstone River and Billings. At this point it interesects and crosses the Northern Pacific R. R. on its way to the Pacific Coast. At present there are 2,000 men and teams employed building the extension.

SOUTHERN PACIFIC.—This company contemplates considerable new work during the coming year. It is stated that one line will start at Fresno and run west a distance of 14 miles, in almost a straight line, to a point on the Westside and Tracy branch, that runs south from Tracy. When this new piece of road is completed, it will, with the line that now runs east from Fresno to Sanger, make a through road across the middle of the valley. Another new line is to start at Bakersfield and run in a southerly direction through the Kern valley. It will be about 50 miles long, and will tap some very extensive deposits of bitumen, as well as open up a fertile and productive section of country. The contract for its construction has already been let. The contract for the completion of the Coast division between Santa Margarita and Elwood will be let soon. Work has been commenced on the new branch from Los Angeles to Armona.

COLORADO MIDLAND.—About 360 men are now at work on the Carbondale, Elk Mt. & Crystal R. R., in Gunnison Co., Colo. Work is making favorable progress and tracklaying will begin in about two weeks.

Projects and Surveys.

SALTAIR.—This company is reported to have completed arrangements for building its proposed railway from Salt Lake City to the Great Salt Lake, about 15 miles, and contracts will soon be let. Gen. Man., Matthew White, Salt Lake City.

TACOMA, LAKE PARK & COLUMBIA RIVER.—Chartered in Washington to build a railway from Tacoma, Wash., to a point on the Columbia River, east of the Dalles. The officers are: Wm. Bailey, New York city,, V.-P.; Wm. Burroughs, Tacoma, Wash., Sec., J. D. Miller, Tacoma, Wash.

ELECTRIC RAILWAYS.

ROCKLAND, ME.—The Edison Co. has the contract for the line to Camden. The road will be 9¼ miles long, laid with 50-lb. rails, and the cars will have motors of 50 HP.

SING SING, N. Y.—The Ossining Electric Ry. Co. has been organized, with a capital stock of $50,000. Pres., Col. E. A. McAlpin; Secy., F. D. Arthur.

NEWARK, N. J.—B. M. & J. F. Shanley are building the electric road to Jersey City, and the Sandford & Stillman Co. is widening the bridges by which the line will cross the Passaic and Hackensack rivers.

PLAINFIELD, N. J.—A franchise for an electric railway on the overhead trolley wire system has been granted to the Plainfield Street Ry. Co.

CHESTER, PA.—The Union Railway Co. will build an electric railway to Media, Pres., Col. S. A. Dyer.

CINCINNATI, O.—Cleveland capitalists have secured a controlling interest in the South Covington & Cincinnati Electric Street Ry. The Madison Ave. line will be extended to Latonia, and extensions built to Ludlow and Dayton, Ky. Among the parties interested are J. J. Shipherd, H. P. Eells and G. H. Kimball, all of Cleveland.

ATLANTA, GA.—The Peachtree Electric Ry. Co. has been organized, and expects to begin construction very soon. Pres., D. C. Bacon; Secy., H. L. Haralson.

KANSAS CITY, KAN.—The elevated railway company has been granted an ordinance permitting it to adopt electric traction.

LEADVILLE, COLO.—The Leadville & Evergreen Lake Ry. will be an electric road, 8 miles long. Dr. John Law and Col. Goodall are interested.

PORTLAND, ORE.—The Barnes Heights & Cornell Mountain Ry. Co. will build a line 9½ miles long, with a maximum grade of 9½%.

CABLE AND ELECTRIC RAILWAYS.

PHILADELPHIA, PA.—The Quaker City Elevated Ry. Co. has had plans prepared for its Market St. line. The columns will be in the street, with cross and longitudinal girders carrying a double track over the street car lines.

DETROIT, MICH.—The Detroit Transit Ry. Co. has been organized by Charles H. Ellis and others, to build an elevated terminal road.

CHICAGO, ILL.—The Metropolitan West Side Elevated Ry. Co. has been granted a franchise for a line from Fifth Ave., west to the city line; $15,000,000: Wm. W. Gurley and others. The Chicago & South Side Rapid Transit Co. has been granted an ordinance for a branch line on 63d St. to Jackson Park. (Eng. News, Jan. 16.)

WEST DULUTH, MINN.—Work is to be commenced shortly on a cable line to Bay View Heights.

HIGHWAYS.

NEW JERSEY.—The town of Rutherford proposes to issue $45,000 in bonds for macadamizing.

WEST VIRGINIA.—Proposals will be received by the Board of Commissioners of Ohio Co., at Wheeling, until April 20, for 44 contracts for grading and macadamizing. Bids for grading must be per cubic yard, and separate for earth, loose rock and solid rock. The macadam must be of 3-in hard blue or gray limestone. W. C. Smith, of Wheeling, is County Engineer. H. H. Pendleton, Clk. of Bd. of Co. Comrs.

OHIO.—Belmont Co. has been authorized to issue an additional $30,000 for turnpikes. Mr. Huston, County Surveyor, of Jefferson Co., has awarded road contracts to Day & Dougherty, of Bellaire; W. H. McCurdy, of Portsmouth; Burchfield & Sanders, of Pekin; and D. L. Peters, of Greenup, Ill. Proposals for the Franklin Park drives, at Columbus, O., will be received until April 23. The engineer is Frank Snyder.

CALIFORNIA.—The City Clerk of National City has been directed to advertise for proposals for building a roadway.

BRIDGES, TUNNELS AND CANALS.

BUFFALO, N. Y.—Bids will be received until April 26 for constructing a wrought iron bridge over the Buffalo River on Bailey Ave. Edwin F. Bishop, Secy., Dept. Pub. Wks, Buffalo, N. Y.

COLUMBUS, O.—Bids will be received until May 2 for building a viaduct over the railway tracks on Leonard Ave. Plans and specifications at County Surveyor's office. Henry J. Caren, County Auditor, Columbus, O.

CHICAGO, ILL.—The Drainage Board will receive proposals until June 8 for the construction of the drainage canal between Willow Springs and Joliet. Earth and rock excavation, 5,000,000 and 11,500,000 cu. yds.; dry rubble walls, 287,241 cu. yds.; slope paving, 244,444 sq. yds. The work will be let in 17 sections. Mr. Benezette Williams is Chief Engineer. See advertisement.

WATER-WORKS.

New England.

ST. JOHNSBURY, VT.—It is reported that a 1,500,000-gallon pump will be added to the village works.

MILLBURY, MASS.—A bill has been reported to the State Senate incorporating Chas. D. Morse, Wm. H. Lincoln and Henry W. Aiken as the Millbury Water Co.; capital stock, $125,000.

SALEM, MASS.—The Council has passed in concurrence an appropriation of $6,000 for the extension of the Wenham Lake intake.

PROVIDENCE, R. I.—It is reported as probable that recommendations will soon be made for the purchase of a 15,000,000-gallon pump for the Pettaconsett station.

Middle.

ALBANY, N. Y.—The bill providing for a new water board, with power to introduce a new, increased or improved supply at a cost of $500,000 has passed the legislature.

ARENA, N. Y.—The Arena Water Co. has been incorporated by Stamford parties; capital stock, $10,000.

BLISS, N. Y.—It is reported that Geo. N. Cowan, Stamford, will investigate proposed gravity works here.

DUNKIRK, N. Y.—Authority is being sought to introduce a gravity supply or add new pumping machinery.

HUNTINGTON, N. Y.—The present franchise will expire May 1, unless its conditions are fulfilled by that time.

SILVER SPRINGS, N. Y.—The Duncan Water Co. has been incorporated.

SYRACUSE, N. Y.—The Commissioners have voted to build a 91,000,000-gallon low, and a 24,000,000-gallon high service reservoir; estimated cost, $193,000 and $44,000, respectively.

EGG HARBOR, N. J.—The Egg Harbor City Water, Electric Light and Power Co. was incorporated April 11, by W. W. Taylor, Philadelphia; C. W. Cason, Camden, and H. May, Egg Harbor City; capital stock, $30,000.

BRYN MAWR, PA.—The Bryn Mawr Water Co. has been incorporated with a capital stock of $1,000; Treas., H. Bayard Hodge. Also the Merion Water Co., with a capital stock of $10,000; Treas., W. W. Wood.

HYNDMAN, PA.—It is said that works will be built by the citizens after plans by J. P. Herdic, Williamsport.

PINE GROVE, PA.—Engr. Fred C. Dunlap, Bullitt Building, Philadelphia, is engaged in making surveys and plans for works. There will be about 3½ miles of 8-in. pipe, and about 1½ miles of 6 and 4-in., and 25 fire hydrants. A dam about 20 ft. high will be built across a ravine, which will give 75 lbs. pressure in the village. Bids will soon be asked.

READING, PA.—The Council has appropriated $125,000 for new mains.

SHIPPENSBURG, PA.—A. B. Stoler is making a survey for an increased supply. A dam is proposed.

BOONSBOROUGH, MD.—The Governor has signed the bill providing for works here.

SMITHSBURG, MD.—Works are projected. C. C. Manning, Hagerstown, will report on the same.

Southern.

ATHENS, GA.—The Council has refused to use for city purposes water furnished by the company, and will proceed, it is said, to construct works, bonds for which have been voted. The city claims that the company has forfeited its franchise by non-compliance.

BARTOW, FLA.—It is reported that the Council has arranged for works to be in operation by January, 1894.

DELAND, FLA.—It is reported that the DeLand Manufacturing Co. will make a proposition to build works, provided a proposed 8-in. artesian well at West DeLand yields a suitable supply.

WAYCROSS, GA.—It is reported that bonds for works have been sold.

ALEXANDRIA, LA.—The "Times" states that Couillard, Welch & Marye have forfeited their franchise through non-compliance and that the field is now open to parties desiring to build works. A later report states that the grantees are making an attempt to retain the franchise.

DONALDSONVILLE, LA.—Edwards & Haubtman, New Orleans, have a contract or a franchise for works estimated to cost $9,917.

EDDYVILLE, KY.—It is said that this place is "calling" for works.

HOPKINSVILLE, KY.—Reports indicate that bids for a franchise will be received until April 25.

North Central.

BRYAN, O.—At a recent election a Council in favor of the water-works was elected, but the proposition to build works was defeated by 14 votes. Authority to issue $30,000 in bonds has been received.

WILLOUGHBY, O.—The people have voted in favor of bonds for works.

BEDFORD, IND.—The Council has let a contract for works to Geo. C. Morgan, Chicago, for $65,628. Works to be completed by Jan. 1, 1893, and to have a daily capacity of 300,000 gallons.

INDIANAPOLIS, IND.—At its annual meeting, April 19, the company will consider proposed improvements, it is said, among which will be the enlargement of the filter gallery.

CHICAGO, ILL.—The contract for a 12,000,000-gallon pumping engine for the Lake View station has been given to the Holly Manufacturing Co., for $48,700, according to the "Times."

MADISON, ILL.—F. G. Neidringhaus, it is reported, has been awarded a contract for works here.

WAUKEGAN, ILL.—The North Shore Water-Works Co. has been incorporated by Camer Remington, Franklin Remington, Chas. F. Griffin and David J. Wile.

MANAWA, WIS.—Fire protection works are proposed.

Northwestern.

ORANGE CITY, IA.—Water and electric lighting plants are under consideration.

PANORA, IA.—Geo. M. Reynolds is Chairman of a committee appointed at a citizens' meeting, to report on works. Estimated cost, $8,000.

DULUTH, MINN.—Cy. Engr. E. H. Keating has reported on proposed city works, designed to meet the wants of the city in 1895. A low, middle and high service is proposed, at a total estimated cost of $884,320; no allowance being made for distributing mains in the low service district. The supply would be from Lake Superior.

GRANITE FALLS, MINN.—The Council has let a contract for works to E. T. Sykes, Minneapolis.

KENYON, MINN.—It is reported that the construction of works has recommenced, and that they will be completed this summer.

LAKE CITY, MINN.—At a recent election the people voted for works, and elected Henry A. Youngs, Mayor.

FREMONT, NEB.—F. L. Burrell, Asst. Cy. Engr., informs us that $30,000 of water-works extension bonds have been voted.

PONCA, NEB.—Bonds to establish works have been sold; amount, $10,000.

Southwestern.

KANSAS CITY, MO.—The people have again voted in favor of issuing $2,000,000 in bonds for municipal water-works.

BRUCEVILLE, TEX.—The Bruceville Water Co. has been incorporated; capital stock, $5,000.

CAMERON, TEX.—It is reported that $8,000 has been subscribed for works.

HILLSBORO, TEX.—It is reported that the parties recently granted a franchise or contract have failed to file the stipulated bond, and that a new franchise or contract will be given.

KARNES, TEX.—It is reported that works are assured.

SAN ANTONIO, TEX.—The West End Water-Works Co. has been incorporated; capital stock, $100,000.

DENVER, COLO.—It is reported that surveys have been begun by the Citizens' Water Co. for a 30-mile pipe line from the South Platte River to the city.

FREMONT, COLO.—It is reported that some of the citizens favor municipal ownership of the proposed works. H. C. McCreery represents Colorado Springs parties, who have made a proposition to build works costing $45,000. Water is now hauled from springs a mile away, and sold for 5 cts. a bucket, or 35 cts. per barrel.

LEADVILLE, COLO.—It is reported that a 1,400,000,000-gallon reservoir will be built in connection with the Leadville & Evergreen Lakes Street Ry. Dr. John Law is interested.

LOUISVILLE, COLO.—The people have voted bonds for works and elected J. A. Snyder, Mayor.

LYONS, COLO.—The people have voted $25,000 of bonds for works, and elected H. N. Morey, Mayor.

Pacific.

ANACORTES, WASH.—The company thinks of introducing a new supply from Heart Lake at an estimated cost of $75,000. A. P. Sharpstein, Mayor.

BALLARD, WASH.—At a recent citizens' meeting the people expressed themselves in favor of municipal works. A limited supply is furnished by the West Coast Water Co., and the Northwestern Artesian, Oil, Gas, and Test Well & Water-Works Construction Co. wish the Council to either grant them a franchise or contract with them for developing an artesian well supply. Address W. R. Ballard or Mayor Rhinehart.

SEATTLE, WASH.—The Council has adopted a report favoring the sale of $205,000 of water and over a million of other bonds to Blair & Co., New York, at 98.04.

SPOKANE, WASH.—City Engineer Oskar Huber has recommended that bids be asked for two 5,000,000 and one 7,500,000 gallon water power pumps, with or without auxiliary steam plants.

TEKOA, WASH.—A franchise has been granted the Edison Electric Light Co. for an electric system, and the city has contracted with the company to do the city's pumping. The water supply will be pumped from a well to an artesian reservoir.

PENDLETON, ORE.—The Council has received a proposition from the Blue Mountain Irrigation Co. to supply 864,000 gallons per day from May 1 to Oct. 1, and 360,000 gallons a day from Oct. 1 to May 1, of each year, for $5,000 per year for ten years. The city now has a pumping system.

ARTESIAN WELLS.

ABERDEEN, S. DAK.—The Dakota Irrigation Co. will sink five wells here.

ARCADIA, FLA.—A. L. Hurd, Kissimee, has a contract to sink seven wells here.

IRRIGATION.

ESCONDIDO, CAL.—According to the "Times," of this place, the contract of the Escondido district with Moffett, Hodgkins & Clarke, Syracuse, N. Y., for a water supply, seems likely to fall through, if it has not already been declared forfeited. The Linda Vista district, or members of it, have talked of joining the Escondido district in a new scheme for a supply.

NEW COMPANIES.—Union Irrigation & Water Power Co., Ogallala, Neb., $20,000; Estrella Fruit Land Irrigation Co., Phoenix, Ariz., Pres., T. J. Evans; Secy., Chas. D. Belden; capital stock, $3,500,000.

SEWERS.

READING, PA.—The Council has appropriated $125,000 for storm water sewers. The city is investigating sewage disposal and seems inclined to contract with the Pennsylvania Sanitary Sewerage Co., of Philadelphia, to introduce the West system.

ROCHESTER, N. Y.—The lowest bids received by the East Side Sewer Commission were Rauber & Vicinus, $113,362, for section 1, and Chambers & Casey, $94,371, for section 2.

PROVIDENCE, R. I.—Sewers are to be constructed in the Mount Pleasant district. The estimated cost is $125,000.

WOONSOCKET, R. I.—Reports have been submitted by Messrs. Shedd and Searle, Chas. E. Allen and Rudolph Hering, and the special committee is now about ready to recommend a system.

HOLLEY, N. Y.—It is expected that the plans will be completed so that bids can be asked within a few days.

OLEAN, N. Y.—It is said that the large pipes will be laid soon. Surveys are being made for a complete system.

POUGHKEEPSIE, N. Y.—Bids are asked until April 21 for 3,000 ft. of 12, 15 and 20-in. pipe sewers. See advertisement.

STAMFORD, N. Y.—Plans and surveys have been made by Chas. E. Brown, Engineer. The estimated cost of the system is $10,000.

RUTHERFORD, N. J.—The committee of 20 recently appointed has petitioned that bonds for $30,000 be issued for a sewer system.

PHILADELPHIA, PA.—Contracts for main sewers, with amount of appropriation for each, have been awarded as follows: Jas. Deehan, $44,500; Jas. F. Kennedy, $20,000; W. H. Achuff, $44,000; Jas. Sullivan, $109,000.

BIRMINGHAM, ALA.—The Mayor has been instructed to contract with the town of Highlands for joint sewerage.

NASHVILLE, TENN.—The lowest bidder for the West End main sewer was J. E. Goodwin, $39,640.

MIDDLEPORT, O.—A sewerage system will be built.

INDIANAPOLIS, IND.—The Board of Public Works has directed the City Engineer to prepare plans for a sewer in East Washington St. It will be 4 or 5 ft. in diameter, about 2 miles in length and built this spring.

BATTLE CREEK, MICH.—Bids are asked until May 26 for both brick and pipe sewers; separate bids for pipe, brick, cement, etc. W. W. Brigden, Chief Engr., Bd. Pub. Wks.

AURORA, ILL.—The Rockford Conatruction Co. was the lowest of 19 bidders. Estimated cost of sewers, $95,000.

CRESTON, IA.—Bids will be asked for pipe sewers.

KANSAS CITY, KAN.—The contract for the extension of the Ohio Ave. sewer to the river, about 1,000 ft., has been awarded to E. H. Bradbury, at $15.40 per ft.

KANSAS CITY, MO.—The city has voted to issue bonds for $200,000 for the O. K. Creek sewer.

WACO, TEX.—Sewer bonds for $30,000 have been sold.

DENVER, COLO.—The contract for the Stout and Glenarm sewer has been awarded to J. P. O'Neil & Co., at $15,152.

SAN FRANCISCO, CAL.—The Supervisors have recommended 12 to 16-in. pipe sewers in eight streets.

STREETS.

NEW YORK, N. Y.—The legislature has authorized the expenditure of $100,000 a year for five years on parkways in the annexed district. The work will be done by the Dept. of Pub. Parks.

BUFFALO, N. Y.—The city will pave 72 streets this spring.

RUTHERFORD, N. J.—The committee recently appointed has asked that bonds for $45,000 be issued for macadamizing the streets.

ALLEGHENY, PA.—The city is considering the advisability of issuing bonds for $1,000,000 for street improvements.

LOCK HAVEN, PA.—Bids will be asked for brick paving.

NORRISTOWN, PA.—Bids are asked until April 28 for curbstone, gutter stone, gutter paving, iron coverings for culverts, etc. Wm. Vaughan, Chn. Com. on Sts.

WILMINGTON, DEL.—Bids are asked until April 26 for 3,760,000 vitrified fire brick for paving. H. J. Wiley, Secy., Bd. of St. Directors.

NORFOLK, VA.—The appropriation for streets is $85,000, much less than is required for the work planned.

AUGUSTA, GA.—One square of Broad St. is to be paved with asphalt at a cost of about $24,000, the company doing the work to pay the city $1.50 per cu. yd. for broken stone.

PORTSMOUTH, VA.—Bids are asked until April 25 for paving material as follows: 262,000 paving brick; 4,400 lin. ft. curbing; 4,400 lin. ft. gutter stone; 1,340 lin. ft. crossing flag stone; 16 corners; 200 perches rubble stone; 42,000 bu. oyster shells; 3,100 loads sand. All material to be delivered on the wharf at Portsmouth, and separate bids for each item. Jas. T. Bogum, Chn. Com. on Sts.

JACKSON, TENN.—The city has made an appropriation for graveling four miles of streets.

SAGINAW, MICH.—The Council has voted to issue bonds for $30,000 to widen Genesee Ave.

YORK, NEB.—The Mayor is urging the city to pave its streets.

ST. LOUIS, MO.—As soon as the appropriations are made it is expected that bids will be asked for $70,000 worth of granitoid sidewalks.

COMANCHE, TEX.—The city has voted to issue bonds for city improvements.

SAN ANTONIO, TEX.—Bids are asked until April 29 for 1,256 ft. of 6 ft. and 280 ft. of 8 ft. concrete walk. Gen. G. B. Dandy, Quartermaster U. S. A.

ALBUQUERQUE, N. MEX.—The Red Mesa Stone & Flagging Co. has been incorporated by C. H. Hubbs, C. Anderson and others; capital, $10,000.

DENVER, COLO.—The Board of Health has voted to pave all the alleys in the city.

OGDEN, UTAH.—The city will issue $50,000 of improvement bonds.

SAN FRANCISCO, CAL.—The Board of Supervisors has voted to pave 11 streets with basalt blocks and 6 with bituminous rock.

MONTREAL, QUE.—The contract for asphalting four streets has been awarded to Bastien & Valiquette, at about $150,000.

ELECTRICAL.

ASHTON, R. I.—The Pawtucket Gas Co. offers to put in 10 lights of 1,200 c. p. each, to burn 300 nights, for $90 per lamp, to light this village and Berkeley. If more lights are put in, and the contracts made for three years, this price will be reduced.

WEEDSPORT, N. Y.—Bids are asked until April 20 for electric street lighting. David Servis, Village Clerk.

McKEESPORT, PA.—The Committee on Water and Lights recommends that the city build a new plant to cost $55,000.

NEW ORLEANS, LA.—The contract for electric lighting has been awarded to the Louisiana Electric Light Co., for 10 years, at $127 per light per year. This company bid $134 per light for a five-year contract, and the Excelsior Electric Light Co., of New York, bid $130 and $140.

BELLEFONTAINE, O.—The city has been authorized to issue bonds for $25,000 for a municipal plant.

MARTIN'S FERRY, O.—The Council has voted to issue bonds for $20,000 for a plant.

BIG RAPIDS, MICH.—Bids are asked by the City Recorder for electric street lighting.

MIDDLETOWN, ILL.—Bids are asked until April 20 for a contract for five years. W. B. Letherbury, Secy., Council.

PINCKNEYVILLE, ILL.—The city proposes to establish a municipal plant.

TACOMA, WASH.—Bonds will be issued for a municipal plant.

CARTERVILLE, ILL.—Mr. F. C. Zimmerman writes us that the City Council, at its meeting on April 11, awarded the contract for electric lighting to A. C. Hope and associates. The city will use incandescent lights of 32 c. p. for street lighting, and agrees to pay $23 per year for each light for the first 60, and $22 per year for each additional light. The Heisler system seems to be preferred, but Mr. Hope has not yet decided what system he will use.

NEW COMPANIES.—Electric Light Co. of Carroll Co., Westminster, Md.; $15,000; Pres., Chas. E. Steward; Treas., Chas. E. Fink. Felt Electric Light & Power Co., New York, N. Y.; $5,000,000; Geo. H. Felt, N. B. Armory and S. L. Felt. Citizens' Electric Light Co., Green Bay, Wis.; $25,000; J. H. Ebelling, W. Hart and F. B. Warren. Denver Electric Co., Denver, Colo.; $500,000; J. A. Cooper, Chas. L. McIntosh and Chas. Boettcher. Rocky Mountain Electric Light & Power Co., of Denver, Colo.; $500,000; M. L. Stern, D. F. Urmy and Geo. H. Hobson.

CONTRACT PRICES.

DREDGING.—New York, N. Y.—The Department of Docks has awarded a contract for removing 25,500 cu. yds. of mud to the Morris & Cumings Dredging Co., at 20 cts. per cu. yd.

Newark, N. J.—The contract for dredging the Passaic River has been awarded to Ross & Sanford, at 60 cts. per cu. yd.

Baltimore, Md.—The contract for dredging Spring Garden has been awarded to the Baltimore Dredging Co., at 13½ cts. per cu. yd. That at Foley's wharf to W. B. Brooks, Jr., at 26 cts. per cu. yd.

Milwaukee, Wis.—The contract for dredging during 1892 has been awarded to Wm. A. Starke, at 18 cts. per cu. yd., in the Milwaukee River, and 15 cts. per cu. yd., in the Menominee and Kinnickinnic rivers.

SEWERS.—Santa Barbara, Cal.—The following contracts have been awarded for the out-fall sewer: Dunham, Carrigan & Hayden Co., iron pipe, 20-in. lap welded, $4.28 per lin. ft.; 20-in. gate and 20 by 20 tee, $171; Hobson & Wilkerson, ironstone sewer pipe, 12-in., 34 cts. per lin. ft.; 16 -in., 57 cts.; 20-in., 80 cts.; Y's, $1.14, $1.36 and $1.60 per lin. ft; excavating and laying pipe, $1.25 per lin. ft.; excavating and laying iron pipe, including 500 ft. in the ocean, $5 per lin ft.; manholes, $65 each; lampholes, $10 each; concrete, $10 per cu. yd.; extra excavation, 45 cts. per cu. yd.; extra filling, 50 cts. per. cu. yd.

Hancock, Mich.—The contract for sewers has been awarded to Andrew Anderson, of St. Paul, at $17,728. The average depth is 10 ft., and the itemized bids are as follows: 8-in., 90 cts.; 10-in., $1.05; 20-in., $1.65; 22-in., $1.95; 24-in., $2.20; catch basin connections, $1.15; manholes, $45; lampholes, $6; flush tanks, $75; catch basins, $50 and $55; submerged iron outlet pipe, 10-in., $1.50; wood sewer, 30 by 30-ins., $1.25. Chas. F. Loweth, of St. Paul, is the Consulting Engineer.

BRICK PAVING.—Dubuque, Ia.—The itemized bid of Atkinson & Oloff, of Rock Island, Ill., to whom was awarded the contract for paving Main St., is as follows: Resetting old curb, 9 cts.; new curb, 50 cts.; granite over macadam or concrete, $1.69; brick on macadam, $1.43; brick on concrete, $1.69. The contract is for Galesburg brick on a 6-in. concrete foundation, and the street is at present paved with 8 to 12-ins. of macadam. E. C. Blake is City Engineer.

PIKE.—Steubenville, O.—Bids for 14 miles of pike have been opened by the County Surveyor, and vary as follows: Earth excavation, 15 to 30 cts. per cu. yd.; rock excavation, 30 to 70 cts. per cu. yd.; broken stone, 97 cts. to $1.80; crushed stone, $1.65 to $3; 4-in., sewer pipe, 10 to 30 cts. per lin. ft.; 8-in., 30 cts. to $1.25; 18-in., 60 cts. to $1.50; 24-in., 75 cts. to $2.25; dry masonry, $3.75 to $5.60 per cu. yd.; culvert masonry, $3 to $6; preparing roadbed, 75 cts. to $1.75 per sq. yd.

PAVING AND GRADING.—Milwaukee, Wis.—The Board of Public Works has awarded contracts for cedar block paving at $1.09 per sq. yd.; granite block paving, $2.27 per sq. yd.; stone curbs, 43 to 57½ cts. per lin. ft.; gutter paving, 34 to 40 cts. per sq. yd.; grading, 30 to 88 cts. per cu. yd.

WATER-WORKS SUPPLIES.—Allentown, Pa.—Contracts have been awarded as follows: Warren Foundry & Machine Co., of Phillipsburg, N. J., 4-in. and 6-in. pipe, $24.50 per ton; specials, 2⅝ cts. per lb.; M. G. Young & Co., lead, 4¾ cts. per lb.; Ludlow Valve Manufacturing Co., of Troy, N. Y., fire hydrants, $29.70 cts. each.

Toronto, Ont.—Contracts have been awarded as follows: Samuel Benjamin & Co., lead pipe, $3.14 per cwt.; Alexander Gartshore, of Hamilton, iron pipe, 4, 6 and 12 in., $32 and $31.25 per ton; Ontario Lead & Barb Wire Co., English pig lead, $3.12 per cwt.

PIPE LAYING.—Milwaukee, Wis.—The contract for laying water mains has been awarded to N. Forrestal as follows: 6-in., 22½ cts. per lin. ft.; 8-in., 28 cts.; 12-in., 39½ cts.; 16-in., 49½ cts.

SUPPLIES.—New York, N. Y.—The Department of Docks has awarded contracts as follows: Bell Brothers, 3 and 4-in. spruce lumber, $21 per 1,000 ft., B. M.; John A. Banker, cobble stones, 5,000 cu. yds., 73 cts. per cu. yd.; Brown & Fleming, rip-rap stone, 4,500 cu. yds., 35 cts. per cu. yd.

STREET AND SEWER.—Jersey City, N. J.—The following proposals have been received by the Board of Street and Water Commissioners for the improvement of Germania Ave., and the construction of a main sewer in Dwight Ave. and Garfield Ave. to New York Bay. The bidders were as follows: Street improvement—(1) R. J. Clarkson; (2) A. Minardow; (3) H. H. Holmes; (4) Chas. O'Neil; (5) John Nolan; (6) Henry Byrne; (7) P. T. Plunkett; (8) M. Curley; (9) Thomas McNeil; (10) Thomas Cavanagh; (11) Edward O'Donnell. Sewer—(12) Thomas Kelly; (13) Henry & McGivney; (14) H. H. Holmes; (15) P. T. Plunkett; (16) Henry Byrne; (17) F. C. Meehan; (18) M. Curley; (19) Thomas Cavanagh. The contract for the street work was awarded to H. H. Holmes, and will amount to about $20,000. The sewer contract was awarded to Thos. Kelly, at about $45,000.

Germania Ave.	1	2	3	4	5	6	7	8	9	10	11
Earth excav. per cu. yd.....$	.34	.40	.24	.28	.30	.30	.25	.19	.30	.35	.25
Rock excav., per cu. yd.....	.34	1.50	1.00	1.75	1.50	2.00	2.00	1.20	.50	2.00	1.00
Earth filling, per cu. yd.....	.34	.25	.04	.01	.05	.25	.10	.05	.20	.10	.25
Sand or gravel filling, per cu. yd..	.35	.80	.80	.80	.70	1.00	1.00	1.25	.70	1.00	1.00
Bridge stone, per sq. ft.....	1.00	.50	.50	.40	.40	.40	.40	.45	.60	.45	.75
Flagging, per sq. ft.....	.15	.16	.16	.15	.15½	.15	.15	.16	.17	.14	.17
Receiving basins, each.....	100.00	80.00	80.00	70.00	75.00	100.00	85.00	100.00	90.00	100.00	125.00
18-in. drain pipe, per lin. ft.....	1.25	2.50	1.50	1.25	.80	1.00	1.50	1.65	1.00	2.00	1.40
12-in. drain pipe, per lin. ft.....	.90	1.20	1.00	.90	.60	1.00	1.00	1.20	1.00	1.00	1.25
Stone masonry, per cu. yd.....	2.00	1.50	5.00	2.50	2.25	10.00	5.00	2.75	4.25	4.00	4.00
Brick masonry, per cu. yd.....	10.00	1.00	9.00	5.00	1.00	10.00	10.00	20.00	4.25	10.00	8.00

Dwight Street Sewer.	12	13	14	15	16	17	18	19
48-in. cast iron pipe sewer, per lin. ft.....	$7.00	$12.00	$10.00	$9.40	$10.00	$11.90	$10.90	$11.50
36-in. cast iron pipe sewer, per lin ft.....	5.00	8.00	8.00	7.40	7.00	9.25	8.75	8.50
54-in. brick circular sewer, per lin. ft.....	5.00	7.00	6.00	5.50	7.00	7.25	5.40	6.50
48-in. brick oval sewer, per lin ft.....	5.00	6.00	5.00	5.35	7.00	7.25	4.50	6.50
30-in. brick oval sewer, per lin. ft.....	5.00	3.00	4.00	3.60	3.00	3.50	3.50	4.00
Piles, per lin. ft.....	.12	.22	.15	.12	.16	.13	.17	.15
Coping, per lin. ft.....	2.00	.55	1.00	1.00	.50	.80	.50	1.00
Capping, per thousand feet (B. M.).....	35.00	25.00	22.00	20.00	5.00	30.00	17.00	28.00
Sheathing, per thousand feet, (B. M.).....	5.00	35.00	10.00	12.00	10.00	28.00	17.00	28.00
Rock excav., per cu. yd.....	1.00	3.60	2.00	2.00	2.50	2.25	2.40	3.00
Brick masonry, per cu. yd.....	9.00	11.00	10.00	10.00	10.00	7.50	10.00	10.00
Receiving basins, each.....	90.00	95.00	75.00	73.00	100.00	90.00	75.00	100.00
Concrete, per cu. yd.....	2.00	7.00	1.00	1.50	5.00	.75	1.50	2.00
Iron bolts, per lb.....	.05	.04	.02	.05	.04	.04	.04	.08

SEWERS.—Orange, N. J.—The following table gives the details of the bids for the two sections of sewerage construction, the contracts for which were noted last week as awarded to Lee, Smith & Co., of Paterson, N. J., at $134,000 for the outlet section, and to Reynolds, Conway & Co., of Newark, N. J., for $136,000, for the valley section. The bidders and totals were as follows: Outlet section—(1) Sandford & Stillman Co., of Newark, $192,000; (2) Edward McGovern & B. E. Malone, of Lancaster, Pa., $183,000; (3) Lee, Smith & Co., of Paterson, N. J., $134,000; (4) Aycock & Siddall, of Trenton, $191,000. Valley section—(5) Sandford & Stillman Co., of Newark, $147,000. (6) Reynolds, Conway & Co., of Newark, $136,000; (7) Empire Construction Co., of New York, $158,000.

Outlet Section.	1	2	3	4
24-in. vitrified pipe sewer, per lin. ft.....	$3.00	3.60	$2.82	$3.26
28x46-in. brick sewer, per lin. ft.....	4.60	5.50	3.57	6.23
48-in. circular brick sewer, per lin. ft.....	4.00	6.50	4.65	7.98
Man holes, per vertical foot, less than 12.....	4.00	3.60	2.40	3.50
Manholes, per vertical foot, more than 12.....	5.00	2.40	3.00	4.50
Flush tanks complete.....	75.00	150.00	50.00	75.00
Rosendale cement concrete per cu. yd.....	6.00	4.50	3.40	4.00
Portland cement concrete, per cu. yd.....	7.50	6.25	4.60	6.25
Brick work in Rosendale cement, per cu. yd.....	12.50	9.00	8.00	10.50
Brick work in Portland cement, per cu. yd.....	16.00	10.50	10.00	13.50
Rubble masonry, in Rosendale cement, per cu. yd.....	9.00	6.00	8.00	4.00
Rubble masonry, in Portland cement, per cu. yd.....	10.00	7.00	10.00	6.00
6-in. underdrain, per lin. ft.....	.50	.20	.10	.30
Excavn. below grade, per cu. yd.....	2.00	1.00	.50	1.00
Rock excav., per cu. yd.....	3.75	2.00	4.60	3.00
6-in. piles, driven to grade, per lin. ft.....	.20	.16	.10	.30
Iron castings, per lb.....	.04	.02¾	.01¾	.02½
Wrought or rolled iron, per lb.....	.05	.03¾	.03½	.03½
Cast iron pipe for stream crossings, per ton.....	60.00	33.00	90.00	40.00
Timber foundations, per 1,000 ft. B. M.....	30.00	25.00	3.00	16.00
Sheathing left in trench by order, per 1,000 ft. B. M.....	30.00	25.00	3.00	16.00
Earth excavation for tidal chamber, per cu. yd.....	.35	.25	.20	.30
Extra haulage at tidal chamber, per cu. yd.....	.10	.03	.10	.10

Valley Section.	5	6	7
78-in. brick sewer, per lin. ft.....	$14.00	$14.00	$15.60
72-in. " " "	14.00	12.75	16.00
48-in. " " "	7.00	7.15	9.50
36-in. " " "	5.50	5.00	6.50
33-in. " " "	4.00	4.40	6.50
24-in. pipe sewer, per lin. ft.....	3.50	2.50	2.50
12-in. basin connections 6 ft. deep, per lin. ft.....	1.00	.55	1.00
10-in. inlet connections 6 ft. deep, per lin. ft.....	.80	.50	.75
18-in. vitrified pipe sewer, per lin. ft.....	2.15	2.30	2.40
Y's in 18-in. pipe sewer, in excess of sewer cost.....	*2.00	1.70	3.00
18-in. iron pipe sewer, per lin. ft.....	2.15	2.20	2.60
10-in. iron pipe sewer, per lin. ft.....	1.17	1.35	1.50
12-in. pipe sewer, per lin. ft.....	1.30	1.37	2.25
Y's in 12-in. pipe sewer, in excess of sewer cost.....	1.00	.74	2.50
9-in. sewer pipe, per lin. ft.....	1.00	1.20	.75
Y's in 9-in. pipe sewer, in excess of sewer cost.....	.70	.46	2.50
8 in. pipe sewer, per lin. ft.....	.75	.75	.87
Y's in 8-in. pipe, in excess of sewer cost.....	.50	.40	1.00
6-in. house con'tions, sewer to curb, 6 to 8 ft. deep in	telford streets, per lin. ft.	.60	.50	.60
6-in. house con'tions, sewer to curb, 8 to 10 ft. deep in	telford streets, per lin. ft.	.70	.60	.60
6-in. house con'tions, sewer to curb, 6 to 8 ft. deep in	dirt streets, per lin. ft..	.50	.40	.60
6-in house con'tions, sewer to curb, 8 to 10 ft. deep, in	dirt streets, per lin. ft..	.60	.50	.60
Manholes, per vertical foot, less than 12.....		4.00	2.40	3.00
" " " " more than 12.....		5.00	3.00	3.00
Basins complete with head.....		100.00	115.00	85.00
Inlets complete with head.....		40.00	75.00	60.00
Flush tanks complete, inclusive of covers and steps, but exclu. of internal fittings		50.00	70.00	55.00
Lamp holes, per vertical foot.....		1.50	2.50	1.50
Concrete, per cu. yd.....		6.00	5.00	5.00
Rock excavation, per cu. yd.....		3.75	3.00	5.00
Iron castings, per lb.....		.04	.03	.02¾
Iron pipe substituted for vitrified pipe, per gross ton.....		60.00	25.00	75.00
Timber foundations, per 1,000 ft. B. M.....		30.00	25.00	50.00
Sheathing left in trench, per 1,000 ft. B. M.....		35.00	20.00	34.00
Excavations below grade to secure foundation, per cu. yd.....		1.70	.75	5.40
2½-in. tile laid, per lin. ft.....		.25	.16	.12
3-in. " " " "		.26	.16	.12
4-in. " " " "		.28	.20	.25
6-in. " " " "		.30	.22	.50
8-in. " " " "		.33	.25	.60

* For 10-in. pipe sewer, 90 cts. per lin. ft. For Y's in 10-in. pipe sewer, 77 cts. per Y.

IRON AND STEEL.—Chicago, Ill.—The lowest bid received by Capt. W. L. Marshall for iron and steel for Kampsville Lock Gates was that of the Russel Wheel & Foundry Co., of Detroit, as follows: Steel, 40,200 lbs., 5.95 cts. per lb.; wrought iron, 45,000 lbs., 5.45 cts. per lb.; cast iron, 112,500 lbs., 4.45 cts. per lb.

MISCELLANEOUS.

DRY DOCK.—Washington, D. C.—Bids are asked until July 5 for a dry dock, 605 ft. long with 30 ft. draft of water, with body of timber and entrance of concrete and masonry, together with pumping plant, etc., for the Puget Sound Naval Station, Sidney, Wash. N. H. Farquhar, Chief of Bureau of Yards and Docks.

DREDGING.—Ottawa, Ont.—Bids are asked until April 19 for dredging Hamilton Harbor, and until April 22 for dredging River Kaministiquia. E. F. E. Roy, Secy., Dept. Pub. Wks.

PUBLIC BUILDING.—The Senate has appropriated $100,000 for a public building at Allentown, Pa.

STONE POSTS.—Lytle, Ga.—Bids are asked until May 3 for 100 stone boundary posts, dressed, marked and numbered. Chickamauga Park Comrs.

DITCH.—Columbus, Neb.—Bids are asked until April 28 for a drainage ditch from the Union Pacific to the Loup River. Gus. Falbaum, City Clerk.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., have an order for 50 engines for the Great Northern. The Rhode Island Locomotive Works, Providence, R. I., are building a Forney tank engine for the Wheeling Bridge Terminal. The Pittsburg Locomotive Works, Pittsburg, Pa., are building five engines for the Pittsburg & Lake Erie.

CARS.—The Roanoke Machine Works, Roanoke, Va., have an order for 250 hopper gondola cars of 50 lbs. capacity, for the Pennsylvania. The Ensign Car Mfg. Co., Huntingdon, W. Va., is building 500 Canda cattle cars for the Missouri Pacific, 250 fruit cars for the Louisville & Nashville, and 200 coal cars for the Chesapeake & Ohio. The South Baltimore Car Works, Baltimore, Md., are building 850 coal cars for the Baltimore & Ohio. The Harvey Steel Car & Repair Co., of Chicago, has been incorporated by T. W. Harvey, E. E. Kaufman and Robert Titus, with a capital of $250,000.

THE RIEHLE BROS. TESTING MACHINE CO. is equipping its testing laboratory at Philadelphia, Pa., with several new testing machines, and is prepared to make tests of all kinds of material.

THE KING BRIDGE CO., Cleveland, O., has elected the following officers for the ensuing year: Pres., Zenas King; Vice-Pres., J. A. King; Treas., H. B. Gibbs; Secy., H. W. King.

PITTSBURG TESTING LABORATORY.—Messrs. Hunt & Clapp have fitted up a four-story building for offices, laboratories and museum complete, and will concentrate their business in the one building.

THE NYE STEAM VACUUM PUMP CO., Chicago, Ill., is building irrigating pumps of 1,000 and 600 gallons per minute capacity, respectively, for parties in Wichita, Kan., and Milwaukee, Wis. The pump is said to be giving satisfaction for irrigating purposes, and an increasing trade in this field is reported.

THE SCHUTTLER MFG. CO., Chicago, has received orders for its new ratchet track drill from India, Russia, England and New Mexico. This drill is said to be in use on about 60 American railways, several of which have adopted it as their standard.

B. E. TILDEN & CO., manufacturers of car replacers and bridge guards, have removed their offices from Cleveland, O., to the Monadnock Building, Chicago.

NEW COMPANIES.—Vuerpel Switch & Signal Co., East St. Louis, Ill.; $100,000; Morris Wuerpel, C. H. Huff and R. C. Ludlow. North American Sliding Railway Co., New York; $1,000,000; J. C. Chapin, and C. R. Ferguson, of Brooklyn; W. A. Pollock, of New York. Hinckley Brake Co., Trenton, N. J.; $100,000; L. J. Allen and F. C. Lowthorp. Perfected Car Coupler Co., Chicago; $1,000,000; J. A. Hinson, F. S. Woods and P. M. Reagan.

TRADE CATALOGUES.—The firm of A. A. Campbell & Co., doing general contracting business, Rookery Building, Chicago, Ill., would like to receive catalogues, price lists, etc., from manufacturers and supply firms.

CURRENT PRICE LIST.

RAILS.—New York: $30 at Eastern mills; $30.75 at tidewater; old rails, $20 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $21 for iron and $16 to $16.75 for steel. Chicago: $31 old rails, to $19.50 for iron and $13.50 to $14 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.65 to 1.7 cts.; spikes, 1.95 to 2 cts.; track bolts, 2.6 to 2.75 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron and 1.8 to 1.9 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.8 cts. for iron and stee; spikes, 2.1 to 2.2 cts.; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57 1-2 and 47 1-2 per cent. on black and galvanized butt-welded; 67 1-2 and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

FOUNDRY AND PIG IRON.—New York: $14 to $16. Pittsburg: $14 to $15. Chicago: $13.50 to $15.50.

LEAD.—New York: 4.2 to 4.3 cts. Chicago: 4 cts. St. Louis: 4 to 4.05.

STRUCTURAL MATERIAL.—New York: beams, 2.3 to 2.8 cts.; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 1.95 cts. for tank, 2.05 to 2.25 cts. for shell, 2.35 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.1 to 2.2 to 2.3 cts.; channels, 2.1 to 2.2 cts.; angles, 1.85 to 1.9 cts.; tees, 2.5 cts.; universal iron mill plates, 1.9 to 1.95 cts.; sheared steel bridge plates, 1.9 to 2 cts.; refined iron and steel bars, 1.75 cts.; steel plates, 1.9 cts. for tank, 2.1 cts. for shell, 2.25 to 2.3 cts. for flange, 3.75 to 4.1 cts. for firebox. Chicago: beams, 2.25 to 2.5 cts. for standard, 2.57 cts. for small, and 2.7 cts. for 20-in. channels, 2.25 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.5 to 2.6 cts.; universal plates, 1.9 to 2 cts.; sheared steel plates, 1.95 to 2 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.6 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.

Seven Hundred Thousand Cubic Yards

Of grading and a large amount of street construction and sewering is to be done at Granite, five miles from St. Louis. Work to be commenced on or about May 1, 1892. The calculations are now being made to determine the amount of grading to be done and the average haul. Notice of the time when bids will be received and full particulars will be given shortly. 16-tf.

Notice to Contractors.

DREDGING ROCK.—I desire to correspond with capable contractor as to cost of blasting and dredging rock bottom, for harbor. Address JOHNSON, care Kneeland & Co., New York. 16-3t.

City of Boston.

BOSTON WATER-WORKS.

To Builders of Pumping Engines.

Sealed proposals addressed to the Boston Water Board, indorsed "Proposal for High-service Pumping Engine No. 3" will be received at the office of the Boston Water Board, City Hall, Boston, until 12 o'clock M. of Thursday, the twelfth day of May, 1892, and at that time will be publicly opened and read.

The price proposed is to cover all the expenses incidental to the completion of the work in full conformity with the plans and specifications. The price proposed must be stated both in writing and in figures, and all proposals containing bids not called for in this advertisement will not be entertained. Each bid must be signed by the bidder, and accompanied by a properly certified check for two thousand dollars ($2,000) payable to the city of Boston; said check to be returned to the bidder unless forfeited under the condition herein stipulated. No bid will be considered which is unaccompanied by a certified check, as aforesaid.

The amount of the security required for the fulfillment of the contract will be the sum of five thousand dollars ($5,000) in cash, and a bond for twenty-five thousand dollars ($25,000), with sureties satisfactory to the Boston Water Board and residents of Massachusetts.

The person or persons to whom the contract may be awarded will be required to appear at this office with the securities offered by him or them, and execute the contract within six days (not including Sunday) from the date of notification of such award, and of the preparation and readiness for signature of the contract; and, in case of failure or neglect to do so, he or they will be considered as having abandoned it, and the certified check accompanying proposal shall be forfeited to the city of Boston.

Plans may be seen, and specifications and form of contract can be obtained, at the office of the City Engineer, City Hall, Boston.

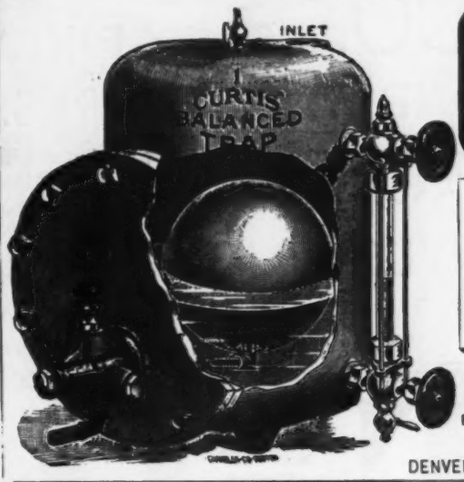
The Water Board reserves the right to reject any or all bids, should it deem it to be for the interest of the city of Boston so to do. Boston Water Board, by

ROBERT GRANT, Chairman.

Office of Boston Water Board,
City Hall, Boston, April 11, 1892 16-2t

TREASURY DEPARTMENT, OFFICE SUPERVISING Architect, Washington, D. C., April 12, 1892. Sealed proposals will be received at this office until 2 o'clock, p. m., on the 12th. day of May, 1892, and opened immediately thereafter, for all the labor and materials required for the cut stone work and brick work, iron and wood floor, ceiling and roof construction, roof covering, terra cotta works, &c., for the superstructure, of the U. S. Post Office building at Lowell, Mass., in accordance with drawings and specifications, copies of which may be had on application at this office or the office of the Superintendent at Lowell, Mass. Each bid must be accompanied by a certified check for a sum not less than 2 per cent. of the amount of the proposal. The right is hereby reserved to reject any or all bids, or to waive any defect or informality in any bid, if it be deemed in the interest of the Government to do so. All proposals received after the time stated will be returned to the bidder. Proposals must be enclosed in envelopes, sealed and marked, "Proposals for the Cut Stone Work and Brick Work, Iron and Wood Floor, Ceiling and Roof Construction, Roof Covering, Terra Cotta Work, &c., for the Superstructure of the U. S. Post Office building at Lowell, Mass." and addressed to W. J. EDBROOKE, Supervising Architect. 16-2t

PROPOSALS FOR IRON OR STEEL Draw Bridge, U. S. Engineer Office, 507 West Chestnut St., Louisville, Ky., April 18, 1892.—Sealed proposals, in triplicate, will be received at this office until 1 p. m. (Standard time), on Tuesday, the 10th day of May, 1892, for the removal of the old bridge at the new locks of the Louisville and Portland Canal, Louisville, Ky., and for replacing it by a new one of wrought iron or steel. The attention of bidders is invited to acts of Congress of Feb. 26, 1885, and Feb. 23, 1887, Vol. XXIII., page 332, and Vol. XXIV., page 414, Statutes-at-Large. Preference will be given to material of domestic production, conditions of quality and price being equal. The right is reserved to reject any and all bids. Specifications and printed forms for proposals will be furnished on application to the undersigned. G. J. LYDECKER, Lt.-Col., Corps of Engineers, U. S. A. 17-3t



CURTIS BALANCED STEAM TRAP

VITAL POINTS OF SUPERIORITY.

The valve area is equal to the area of pipe connections, and being perfectly balanced, is frictionless.

The two great objections to all other Floats — tendency to fill or collapse under heavy pressure — are entirely overcome in the Curtis Balanced Steam Trap. Our Float is of hard composition, perfectly round; is the strongest Float made, besides being vented to the atmosphere.

Is used under pressure varying from 1 to 130 pounds.

It is a water-line Trap, always sealed with several inches of water.

FULL INFORMATION CHEERFULLY FURNISHED BY

GENERAL AGENCIES:
NEW YORK, 109 Liberty St.
PHILADELPHIA, 2035 N. Front St.
CHICAGO, 218 Lake St.
DENVER, Corner 15th and Arraphoe Sts.

The Curtis Regulator Co.
63 Beverly Street, BOSTON, MASS.

PROPOSALS FOR STEAM POWER Plant, Watervliet Arsenal, West Troy, N. Y., April 15, 1892.—Sealed proposals, in triplicate, will be received at this Arsenal until 12 o'clock noon, on Monday, May 16, 1892, for furnishing a steam power plant, comprising steam engine, boilers, etc., and for the delivery and erection of same in complete running order in the Army Gun Factory at Watervliet Arsenal. The Government reserves the right to reject all or any proposals or parts thereof. Specifications and all other information can be had on application to Lieutenant-Colonel F. H. PARKER, Ordnance Department, U. S. A., Commanding.

U. S. ENGINEER OFFICE, CHARLESton-Kanawha, W. Va., April 11, 1892.—Proposals for iron work for movable dams on the Great Kanawha River, embracing about 495,000 lbs. of wrought iron, and 38,500 lbs. of cast iron, and two maneuvering winches, will be received at this office until 3 p. m., May 25, 1892, and then opened. The attention of bidders is invited to the acts of Congress, approved Feb. 26, 1885, and Feb. 23, 1887, Vol. XXIII., page 332, and Vol. XXIV., page 414, Statutes at Large. Full information can be obtained by application to Addison M. Scott, Resident Engineer, at the above office. WM. P. CRAIGHILL, Col. Corps of Engineers, U. S. A. 17-4t

PROPOSALS FOR THE CONSTRUCTION OF A RESERVOIR.

Sealed proposals will be received by the Committee on Reservoir and Water Supply up to 5 o'clock p. m., Monday, May 16, 1892, for the construction of a 15,000,000 and 20,000,000 gallon reservoir, including gate house and appurtenances, on the tract of land of V. C. Sweatman, west of Franklin and Marshall College, Lancaster, Pa.

Bids to include taking up of old 24-in. main from the old water-works to the present reservoirs, and the relaying of the same from the corner of Orange and Nevin to the above mentioned site. Plans and specifications can be seen at the office of A. A. Herr, City Regulator, No. 108 East King St., Lancaster, Pa., or specifications will be mailed to parties applying for the same on application to the Clerk.

Bids to be addressed to Committee on Reservoir and Water Supply, Mayor's Office, Lancaster, Pa.

ROBERT CLARK, Mayor,
Chairman.

Attest, C. G. Bassler, Clerk. 17-3t

STREET PAVING, ROANOKE, VA.

Proposals will be received at this office until 12 o'clock noon, May 6, for paving streets in Roanoke, Va., with granite blocks and vitrified brick. For full information and specifications, apply to the office of the Board of Public Works, Roanoke, Va. 17-2t

PROPOSALS FOR STONE BRIDGE.

Sealed proposals will be received by the Selectmen and Bridge Committee of the town of Middlebury, Vt., until May 2, 1892, at noon, for the building of a stone bridge over Otter Creek, in the village of Middlebury, said bridge to be about 160 ft. in length.

Plans and specifications can be seen on application to the subscriber at Middlebury. Each bid must be accompanied by conclusive evidence of the financial responsibility of the bidder. The Selectmen and Committee reserve the right to reject any and all bids. Bids must be sealed, indorsed "Bid for Stone Bridge," and addressed to Selectmen and Bridge Committee, Middlebury, Vt. E. J. MATHEWS, Chairman.

Middlebury, Vt., April 19, 1892. 17-2t

BUY your BOOKS from

Engineering News Pub. Co.

ESTABLISHED 1840.

GEO. J. BURKHARDT SONS,

(Successors to GEO. J. BURKHARDT & CO.

FACTORY, 2831-2839 N. BROAD ST.,

Near Germantown Junction Station, Pennsylvania R. R.

Down Town Office:

No. 240 Chestnut Street, Philadelphia.

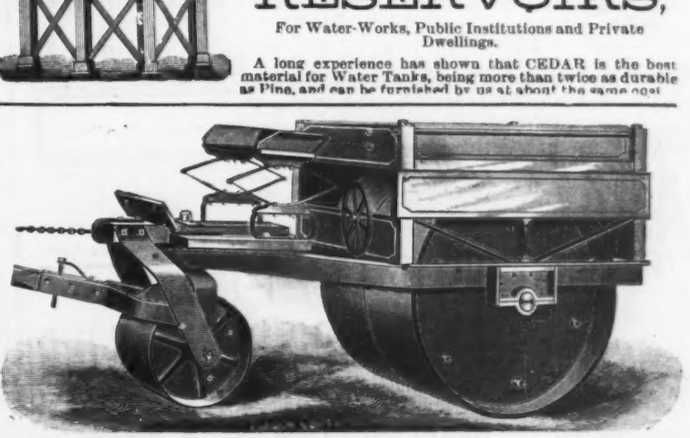
CEDAR TANKS,

For Railroads, Factories, Iron Works, etc.

RESERVOIRS,

For Water-Works, Public Institutions and Private Dwellings.

A long experience has shown that CEDAR is the best material for Water Tanks, being more than twice as durable as Pine, and can be furnished by us at about the same cost



For Circulars of the Best Street Paving Rollers, Address

ENTERPRISE MFG. CO., 104 Main Street, Columbiana, Ohio.

LABOR.

JOSEPH BRUNO, *Contractor.*

Italian laborers supplied and work superintended. Address 15 London St., East Boston, Mass.

DONATO CUOZZO,
Contractor Italian Labor.
See Adv., p. iv.

ANY CONTRACTOR

Or company needing laborers address M. MEOLA, Box 54, Wheeling, W. Va.

CHARLES P. MARTINO.

Italian laborers supplied for railroads, waterworks, etc. Address 242 N. 5th St., Brooklyn, E. D., N. Y.

THE ELECTRIC RAILWAY IN THEORY AND PRACTICE.—By O. T. Crosby and Louis Bell, 8vo. 389 pages. New York, 1892. Price, $2.50. Now that electricity is rapidly driving out all other methods of street car propulsion, a really good treatise, such as this is very timely. It is the only book on the subject worthy of mention, and it is for sale by Engineering News Publishing Co., Tribune Building, N. Y. City.

World's Fair Route.

The Cincinnati, Hamilton & Dayton R. R. is the only line running Pullman's Perfected Safety Vestibuled Trains, with Chair, Parlor, Sleeping and Dining Car Service, between Cincinnati, Indianapolis and Chicago, and is the Only Line running Through Reclining Chair Cars between Cincinnati, Keokuk and Springfield, Ill. It is the popular line between Cincinnati and St. Louis with Through Sleeping Cars on Night Trains and Chair Cars on Day Trains, and the Only Direct Line between Cincinnati, Dayton, Lima, Toledo, Detroit, the Lake Regions and Canada.

Tickets on sale everywhere, and see that they read C., H. & D., either in or out of Cincinnati, Indianapolis, or Toledo. E. O. McCORMICK, General Passenger and Ticket Agent, Cincinnati, O. eow

PROPOSALS FOR OBSERVATION TOWers.—Office of the Chickamauga Park Commissioners, War Department, Washington, D. C., April 9, 1892. Sealed proposals in triplicate, with guarantees and designs, for furnishing six wrought iron towers, will be received at this office until noon of May 24, 1892, and opened immediately thereafter in the presence of bidders. The right to reject any or all proposals is reserved to the United States. Specifications and blank forms of proposals will be furnished established manufacturers and contractors, on application to the Commissioners, J. S. Fullerton, A. P. Stewart and S. C. Kellogg. 15-eow-3t

WANTED—Place as rodman, chainman or masonry inspector. Leveler's experience with A1 references. Place more than pay. Address W. H. CHRISTIE, Van Ettenville, N. Y.

R. D. WOOD & CO.

Engineers, Iron Founders, Machinists, 400 CHESTNUT STREET, PHILADELPHIA, PA.

CONSTRUCTORS OF GAS AND WATER WORKS.

MANUFACTURERS OF ALL KINDS AND SIZES OF CAST IRON PIPE.

FREEMAN'S VALVE INDICATOR POSTS, EDDY VALVES, LAMP POSTS, ETC. GAS HOLDERS AND GAS MACHINERY.

HYDRAULIC CRANES, PRESSES, LIFTS, ETC. TURBINES AND WATER POWER PUMPS. HYDRAULIC TRAVELING CRANES.

Foundries and Works: MILLVILLE, N. J. FLORENCE, " CAMDEN, "

MATHEWS' SINGLE AND DOUBLE VALVE FIRE HYDRANTS.

CHEMICAL AND SUGAR HOUSE WORK, LOAM CASTINGS, HEAVY SPECIAL MACHINERY, GENERAL CASTINGS

SERVIS TIE PLATES

THE Q AND C CO. CHICAGO AND NEW YORK. The Q and C Co. Chicago & New York. THE Q AND C CO. CHICAGO AND NEW YORK.

THE SAFEST STRONGEST ÆTNA DYNAMITE

THE ÆTNA POWDER CO.

ARE MANUFACTURERS OF

High-Quality Explosives for Blasting, Sporting and Military Purposes,

—AND OF—

APPARATUS FOR BLASTING BY ELECTRICITY.

WRITE FOR PAMPHLET AND PRICES TO

THE ÆTNA POWDER CO., 95 Randolph St., Chicago, Ill

TRAUTWINE'S POCKET BOOK.

"The most useful hand book in the language in the engineering profession."—*Engineering and Mining Journal*, Aug. 25. 1888

CANALS

Waterways and Water Transport in different countries, with a description of the Panama, Suez, Manchester, Nicaraguan and other Canals. By J. S. Jeans. 500 pages, with illustrations; 8vo, cloth, $5.50.

Circulars and catalogues on application.

E. & F. N. SPON, Publishers, 12 Courtlandt St., New York

PATENTED.

WAKEFIELD TRIPLE LAP SHEET PILING

A PILE MADE OF THREE EQUAL WIDTH PLANKS BOLTED TOGETHER.

SIMPLEST. CHEAPEST. BEST.

Easy to make and made any length. Perfectly matched; stands the heaviest of pounding.

NEVER FAILS TO GIVE SATISFACTION.

Don't use old make-shift Sheetings for Dams, Coffer Dams, Docks, Levees or any place where you want to stop water.

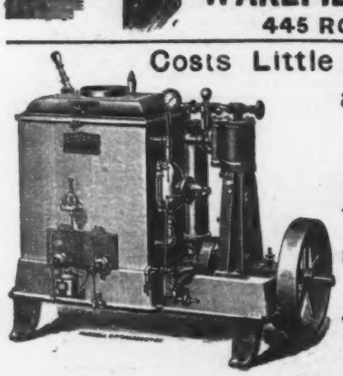
USE THE WAKEFIELD.

PATENTED IN THE U. S. AND CANADA.

—Address for Catalogue and Information.—

WAKEFIELD SHEET PILING CO.,

445 ROOKERY, CHICAGO, ILL.



Costs Little to Buy, Less to Run, and Nothing to Keep.

THE SHIPMAN Automatic Steam Engine

1-2-4-6-8 HORSE POWER.

Burns Natural Gas, Kerosene, etc.

ANY ONE CAN RUN IT.

Write for Catalogues and Full Particulars.

THE SHIPMAN ENGINE COMPANY,

201 Summer St., Boston, Mass.

CAMERON STEAM PUMP

SIMPLE, RELIABLE, COMPACT, DURABLE.

NO OUTSIDE VALVE GEAR. ADAPTED FOR ALL PURPOSES.

THE A·S·CAMERON STEAM PUMP WORKS·

FOOT OF EAST 23d STREET, ·NEW YORK·

PURE ALUMINUM.

THE PITTSBURGH REDUCTION COMPANY, 95 Fifth Ave., Pittsburgh, Pa., Offer Aluminum guaranteed to be equal in purity to the best in the market at the lowest rates obtainable. Prices given on application. Aluminum Sheet, Wire and Castings at best rates.

Aluminum polish, very efficacious and non-poisonous, suitable for household use, as well as for manufacturing purposes

Aluminum solder. Correspondence solicited.

CABLE RAILWAYS.

E. SAXTON,

CONTRACTOR,

WASHINGTON, D. C.

CABLE RAILWAYS BUILT BY E. SAXTON:

Grand Avenue and 15th Street Line, for Grand Avenue Railway Co., Kansas City, Mo.
Grand Avenue and Westport Line, for Grand Avenue Railway Co., Kansas City, Mo.
Holmes Street Line, for Holmes Street Railway Co., Kansas City, Mo.
"The Loop Line," for Metropolitan Railway Co., Kansas City, Mo.
Seventh Street Line, for Washington & Georgetown R. R. Co., Washington, D. C.
Eleventh and Thirteenth Sts. Line, for Tacoma R'y & Motor Co., Tacoma, State of Washington
Navy Yard and Georgetown Line, for Washington & Georgetown R. R. Co., Washington, D. C.
Fourteenth Street Line, for Washington & Georgetown R. R. Co., Washington, D. C.

UNDER CONTRACT:

Blue Line of the Baltimore City Passenger R. R. Co.

GRAPHITE PAINT.

It covers from 2 to 3 times more surface and lasts from 4 to 5 times longer than any lead, mineral or metallic paint. THIS HAS BEEN FULLY DEMONSTRATED.

Send for Circular and Prices. JOS. DIXON CRUCIBLE CO., Jersey City, N. J.

Globe Special Castings,

FOR WATER-WORKS.

BUILDERS IRON FOUNDRY,

PROVIDENCE, R. I.

J. M. DRUMMOND, Sales Agent, 192 Broadway, N. Y. City.